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TECHNOLOGY AND INNOVATION REPORT 2012

Innovation, Technology and South-South Collaboration

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- A dash (–) indicates that the item is equal to zero or its value is negligible.
- A blank in a table indicates that the item is not applicable, unless otherwise indicated.
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- Use of a dash (–) between dates representing years (e.g. 1994–1995) signifies the full period involved, including the beginning and end years.
- Reference to “dollars” ($) means United States dollars, unless otherwise indicated.
- Details and percentages in tables do not necessarily add to totals because of rounding.

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PREFACE

There is no doubt about the potential of rapid technological progress to help the world meet the defining challenges of our time. Yet for many individuals in the developing world, access is still a major challenge, hindering their ability to learn

how to use technologies that would improve their lives and promote enterprise development. That challenge is multiplied many times over for national policymakers seeking to use technologies to address energy poverty, food insecurity, environmental threats and job creation.

Bridging the technological divide has become a core concern of the

United Nations. If we are to build on and expand the progress that has been made towards the Millennium Development Goals, the international community will need to find innovative ways of closing this gap.

The increasing capacity of a growing number of countries in the South is a promising dynamic that signals the beginning of a new era in global development.

As more and more developing countries embark on the process of industrial catch-up, South-South cooperation can help to address the technological divide.

The UNCTAD *Technology and Innovation Report 2012* focuses on how South-South collaboration can help address key capacity questions faced by developing countries. The information and analysis contained in this report mark a welcome contribution to the efforts now getting under way to establish a set of Sustainable Development Goals and to outline a post-2015 development agenda.

I encourage governments and development partners to carefully consider the report's recommendations as we consider how best to promote equitable, sustainable and inclusive development for all.

BAN Ki-moon
Secretary-General
United Nations

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LIST OF ABBREVIATIONS

ABC	Brazilian Cooperation Agency (Agência Brasileira de Cooperação)
AEC	African Economic Community
ARV	antiretroviral
ASEAN	Association of Southeast Asian Nations
AU	African Union
BRICS	Brazil, Russian Federation, India, China and South Africa
CAN	Community of Andean Nations (Comunidad Andina de Naciones)
CARICOM	Caribbean Community
DAC	Development Assistance Committee (of OECD)
ECOSOC	Economic and Social Council (of the United Nations)
ECOWAS	Economic Community of West African States
EMBRAPA	Brazilian Agricultural Research Corporation (Empresa Brasileira de Pesquisa Agropecuária)
EU	European Union
FDI	foreign direct investment
Fiocruz	Oswaldo Cruz Foundation (Brazil)
GDP	gross domestic product
GPN	global production network
IBSA	India, Brazil, South Africa (forum)
ICT	information and communication technology
IIA	international investment agreement
IPR	intellectual property rights
IT	information technology
LDC	least developed country
M&A	merger and acquisition
NAASP	New Asian-African Strategic Partnership
NEPAD	New Partnership for Africa's Development
NIE	newly industrialized economy
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OEM	original equipment manufacturing
PTA	preferential trade agreement (or preferential trading arrangement)
PPP	public-private partnership
R&D	research and development
RET	renewable energy technology

SADC	Southern African Development Community
SITEP	South-South Innovation and Technology Pact
SME	small and medium-sized enterprise
STI	science, technology and innovation
TCDC	technical cooperation among developing countries
TIR	Technology and Innovation Report
TNC	transnational corporation
TRIPS	Trade-Related Aspects of Intellectual Property Rights (or WTO - TRIPS Agreement)
UNCTAD	United Nations Conference on Trade and Development
UNDAF	United Nations Development Assistance Framework
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

OVERVIEW

I. SOUTH-SOUTH COOPERATION IS BECOMING INCREASINGLY IMPORTANT

As more and more developing countries embark on the process of industrial catch-up, it is expected that the new growth poles will increasingly contribute to a changing dynamics in international relations. A process that began with the rapid industrialization of the first- and the second-tier East Asian economies in the 1960s and 1970s[1] has been followed by accelerated industrial growth in a newer set of what are often referred to as emerging countries – India, China, Brazil and South Africa. This ongoing but punctuated process is expected to continue, with additional countries (such as Nigeria and Egypt) experiencing similar growth in the future.

Economic expansion and growth in these countries is attributable to several important and interrelated factors: their growing capabilities in manufacturing and services, greater investments in technologies and efficient use of opportunities arising from globalization. In addition, rising per capita incomes and concomitant growth of domestic demand have further boosted their growth performance. The steady economic growth of these countries has translated into an increase in South-South cooperation in trade, investment and technology over the past two decades, enabling them to become significant global trading partners with other developing countries in the 2000s.

Ongoing South-South cooperation is not restricted to economic factors alone. Some developing countries, along with their strengthening economic clout, are contributing towards reshaping global trade, aid and economic relations. This is partly reflected in their increasing contributions to development cooperation and assistance. Recent studies estimate that development assistance by developing countries has been growing steadily, amounting to $7.3 billion in 2010 (OECD, 2010).[2]

These developments point towards the emergence of a new paradigm for international development, which could extend the existing boundaries of engagement to include those developing countries – particularly least developed countries (LDCs) – that are currently marginalized in the global economic system.

1. Greater South-South cooperation could benefit all developing countries

Rising South-South trade and investment trends have been viewed positively as a signal that some developing countries could provide a significant impetus to growth in developing countries. The literature identifies two main aspects of cooperation among developing countries. First, such cooperation would help the South to decouple from the global cyclical trends of growth, thereby promoting a new form of stability in the global economic system. Second, since the emerging countries are still in their development phase, they are better placed to understand the problems of development, particularly in the current global context, and could provide a new model of cooperation and technical assistance in relation for developing countries.

Moreover, growing South-South cooperation carries with it the promise that it could be channelled into addressing specific development goals. Realising the full potential of South-South cooperation will require significant changes in the way the global economy is governed, to make it more development-oriented. Ways and means to achieve this will also need to be fully explored through policies and practices at the national and regional levels.

Against this background, this *Technology and Innovation Report – TIR 2012* – argues that the time is ripe to move beyond analysing current trends in South-South trade and investment. Specifically, it is important to consider how and to what extent South-South cooperation could help developing countries overcome certain obstacles to economic expansion and growth in order to achieve specific development goals. One such goal, which continues to elude the global community, is to bridge the technological divide so as to promote industrialization and inclusive growth across the developing world.

2. The South can complement the North in promoting technological learning and innovation capacity

Technology and innovation are both difficult to assess within economic transactions, and there is no single indicator that measures them holistically. A long history of empirical research has uncovered a number of international factors shaping the process of technological change and productivity growth. One factor that is a significant contributor to technological learning and capacity-building is the import of capital goods. Participation in global production networks (GPNs) – and in customer-supplier-retailer relationships in these networks – along with foreign direct investment (FDI) are other factors that can promote learning and the building of capabili-

ties through technological spillovers to local firms, either directly through licensing and technology transfer, or indirectly through tacit know-how accumulation by local personnel. These are often supported by other means such as copying, interacting with foreign clients on design, standards and quality requirements, and collaboration in joint ventures.

The impact of these channels on the building of capabilities depends on the presence of some level of absorptive capacity within countries. But since institutions in many developing countries, particularly LDCs, tend to be weak, they are likely to be challenged in their quest to use South-South trade and investment to build their technological capabilities and promote activities leading to structural change and diversification of their economies.

In order to overcome these limitations proactive policies are needed at various levels of South-South exchange. Emerging countries have used a variety of measures to overcome barriers to trade and intellectual property rights (IPR) protection in their own economic development, which can provide important lessons for other developing countries. Their successful experiences show not only how technological capabilities can be built, but also what policy measures could potentially be used to promote national development in the context of the existing multilateral trade regime. The similarity of their developmental experiences is important, deriving from their past path-dependent constraints on promoting sustainable development.

Sharing of experiences amongst developing countries and strengthening their collaboration remains essential and relevant for countries that are still grappling with ways to create harmonious and coherent local innovation and industrial policy environments. Recognizing this, both policy and scholarly analyses have begun to give greater attention to what lessons can be drawn from experiences of emerging countries for development in general, and the process of capabilities building, in particular.

A second and perhaps more appropriate advantage of developing countries for fostering technological learning in the South is that most of them have followed similar pathways in building their capabilities: from reverse engineering to incrementally innovating in products and processes, to increased research and development (R&D) and operating at the technological frontier itself. Even in the developing countries that can be termed as emerging, while there are a number of industries that are at the technological frontier globally, many other industries or firms face routine constraints on innovation similar to those prevailing in other developing countries, including LDCs. This implies that, to varying extents, these countries are still confronted with some basic issues relating to promoting the technological absorptive capacities of their systems as a whole.

The similarity of many of these challenges to innovation lends support to the view that the technologies produced by developing countries may often be much more accessible – and contextually appropriate – to other developing countries and firms, thus highlighting the importance of promoting greater South-South collaboration in this area. Collaboration on technology and innovation is perhaps one of the most critical components of South-South solidarity, offering a real promise of sustainable development throughout the developing world. However, because such collaboration still takes place between developing countries at very different levels of development, it necessarily involves some pressures as well as opportunities for many developing countries. Pressures include conforming with certain requirements imposed by various agreements on international trade and IPR regimes, among others (such as obligations relating to climate change mitigation and adaptation, the transition towards a green economy, and IPRs protection), while ensuring inclusive and sustainable industrial development.

3. Technology and innovation-based collaboration may not be automatic

Given the potential of South-South cooperation to promote technological learning, there is clearly a renewed interest in this area. Key policy considerations include how ongoing South-South cooperation could be oriented to foster technological and innovation capacity, and how the technology needs of all developing countries and LDCs could be integrated into a balanced agenda of cooperation and exchange.

In the classical development economics discourse, economic growth is considered to be a process of mobilizing and combining complementary factors to shift the production structure of economies and extend the production frontier. Those factors are capital accumulation, technological change and economic diversification. In the context of developing countries, however, economic growth, on the one hand, and technology and innovation capacity on the other have a mutually reinforcing relationship. Technology and innovation capacity play an important role in boosting economic growth of the kind that results from changes in the structure of production. Economic growth often enables technological learning and greater sophistication, and at the same time, technological capabilities are critical for ensuring that growth is of a productive nature and can be steadily maintained.

However, these mutually supportive linkages do not emerge spontaneously. Particularly, in the context of South-South exchanges, while there is potential for continued growth of trade and investment that can result in technological learning, much still needs to be done to harness that potential. Firms seeking to expand through a search for newer markets and economies of scope and scale may have only limited incentives to engage in collaborations/ joint ventures with host-country firms. These incentives are usually market-based, depending on the specific attributes of the host country firms that make them attractive partners. This could include their extensive marketing and distribution networks in the host countries, or their specific R&D capabilities or technological expertise, or their ability to produce particular products competitively. However, such market-related incentives only entice firms to enter into alliances with firms in host countries that have some level of expertise, as demonstrated by the value addition they create in return. Relying on such incentives for technological learning is misleading, since they are not sufficient to entice firms on their own to enter into technological learning alliances with partners who have little or low levels of technological expertise.

Moreover, despite the significance of these issues, the literature on South-South technological cooperation is quite scarce, and generally focuses on how pressing international challenges, such as public health and climate change, can be addressed through cooperation amongst developing countries. The analysis tends to be rather general, and data on issues of technological change and innovation capacity are scarce or not easily available. This Report seeks to fill this gap and aims to contribute new policy insights in this complex area.

The Report argues that the similarity of development experiences of the countries of the South (particularly in promoting innovation capacity), and the contextual appropriateness of their technologies, makes them essential complements to existing North-South interactions. The central message of *TIR 2012* is that developing countries, particularly emerging countries, can be important partners for promoting technological capabilities in the South, and therefore analysing how South-South collaboration for technology and innovation can be promoted in a systematic way to promote inclusive sustainable development should be a priority.

Hence, the Report focuses on whether South-South exchanges could lead to building technological capabilities, and under what circumstances. From an analysis of the current patterns of South-South exchanges on technology and innovation issues, the Report seeks to identify key issues in this area, and derive best practices for moving forward in fostering South-South collaboration on technology and innovation.

II. A RICH LANDSCAPE OF SOUTH-SOUTH EXCHANGE IS EMERGING

The growing economic and commercial interests of some developing countries have been fuelling market expansion and some level of technological collaboration with other developing countries. Within these transactions, imports of capital goods and growing participation in GPNs may help local firms accumulate knowledge, not only relating to technical aspects of production, but also to managerial, business and quality-related aspects. FDI and licensing can also have important implications for technology acquisition and learning in some contexts. However, to what extent this holds, and whether economic growth in the South and the resulting rise in South-South trade and investment do indeed contribute to greater technological learning and development of innovation capacity remain pertinent questions from both theoretical and policy-making perspectives.

1. Developing countries are increasingly importing capital goods from the South

Developing countries have surpassed developed countries as major partners of other developing countries for trade in capital goods. Capital goods imports are not only inputs for the expanding economic activities and consumption patterns in these countries, they also show that developing countries, particularly emerging countries, are increasingly offering competitive products in a variety of industries involving a range of technologies.

Available data show that there has been a marked increase in trade in capital goods among developing countries since the mid-1990s. Indeed, overall trends show a clear shift away from developed countries as sources of such goods for developing countries during the period 2005–2010, especially after the economic slowdown in 2008. As part of rising South-South trade, the share of developing countries' imports from other developing countries has increased steadily, from 35 per cent in 1995 to 54 per cent in 2010, which indicates that developing countries have become the main sources of capital goods for other developing countries.

Growing imports of capital goods by developing countries implies the expanding capacity in the South to produce goods, at least in some countries. It also shows that imports of these goods by other developing countries are on the rise as part of their increasing efforts to promote productive capacity. As noted earlier, such imports are important for building productive capacity, since they can result in the transfer of technology to the

extent that the imported goods are studied for design characteristics and reverse engineering. They can also directly improve productivity when they are employed in production processes. The impact of imports of capital goods in terms of enhancing productivity in developing countries is reflected in part by the increasing share of manufacturing exports from developing countries as a whole, a large part of which is also sourced to other developing countries.

Within these broad trends, there has been a consistent increase in imports of high-technology-intensive goods by developing countries. A closer look at the growing technological intensity of South-South imports shows that, on average, over 53 per cent of all high-technology products imported by developing countries as a group was sourced from other developing countries in 2010. Comparing the level of technological intensity (low, medium and high) of developing-country imports, there was a larger share of manufactured imports of high skill and technology intensity than those of medium skill and technology intensity. These trends strengthen the notion that developing countries are increasingly able to export technology-intensive goods globally, and particularly to the South.

2. Developing countries are increasingly participating in global production networks

A predominant factor explaining the rising trend in technology imports is the growth of GPNs, driven by some of the more technologically advanced developing countries. Another factor is the increasing domestic demand in some of the emerging countries – particularly China and India – due to their large populations and the growing purchasing power of their growing middle classes, which is leading to a surge in imports of technological products from other countries in the South into these economies. Many of these imports, as data trends show, serve to meet growing demand driven by the expanding economic activities and consumption patterns in these countries. Moreover, some emerging countries are able to manufacture several high-technology products at competitive prices, resulting in a shift in developing-country imports from developed countries to developing countries.

However, these trends are uneven across regions, and are largely explained by the existence of production networks in countries in East Asia, and more recently in South-East Asia and South Asia. These countries have progressed in technological sophistication as illustrated by their ability to produce high- and medium-technology-intensive products using advanced processes. This further facilitates their ability to absorb newer products that also embody high skills and technology intensity much better than some of the other regions shown in table 3, such as Southern Africa. Similar trends can be observed with respect to medium-technology-intensive imports.

Generally, a country can import capital goods so long as it can pay for them. However, what remains important for productivity growth is how these imports are channelled effectively into generating future income. This relates to how firms and sectors are able to adapt and use technologies embodied in these imports to generate productivity growth. So long as this is possible and evident, it would lead to the conclusion that such imports of capital goods are contributing to building technological capabilities in developing countries. On this aspect, two trends stand out.

First, developing countries that already have a minimum level of technological capabilities are engaging in extensive trade in capital goods with other countries of the South. This points to the importance of some level of technological capabilities to participate in capital goods trade, underscoring the fact that while any country can import capital goods, those that consistently participate in trade in such goods use many of these imports to enhance their production capacities.[3] The second trend, which to some extent supports the first, is that there is a significant overlap between countries that import capital goods and those that export technology-intensive goods. Hence, a sub-set of developing countries that already possess some level of technological capabilities are able to leverage ongoing trade and investment to further boost their technological capabilities and innovation capacities.

This does not completely exclude the presence and importance of technological transactions in other countries of the South. But it points to an important result that many are limited by the smaller size of their markets, lower ability to pay and the lower technological intensity of their overall economic activity.

Trends in imports of machinery and transport equipment show a widening gap among developing countries, confirming the overall trends presented here regarding the technological capacity of countries. Developing countries as a group increased their imports of machinery and transport equipment as a share of global imports of this category from 27 per cent in 1995 to 53 per cent in 2010. However, countries with lower technological capacities, such as a large number of LDCs, increased the share of their imports of this category from only 0.04 per cent in 1995 to 0.08 per cent in 2010, which is much lower than that of other developing countries.[4] Among the LDCs, there are further variations, with the oil-export-

ing LDCs largely accounting for the increase in these imports, showing that such imports are biased towards the commodity sectors in the oil exporting LDCs.[5]

3. South-South FDI has been rising

FDI by developing countries has been rising in recent years, increasing the possibilities for it to be leveraged for technological learning in various other developing countries. The importance of developing countries as sources of FDI has increased quite significantly and steadily over the past four decades,[6] although it declined somewhat in 2008, following the eruption of the financial and economic crisis. The share of developing countries in total outward FDI rose from 15 per cent in 2005 (from $132 billion) to 27 per cent in 2010 ($400 billion), but preliminary estimates for 2011 indicate that it may have declined to 21.4 per cent for the year.[7] The analysis of South-South FDI leads to the following main observations:

- Although there has been a substantial rise in South-South FDI, there are significant regional variations in outward FDI which have an impact on the share of gross fixed capital formation in countries. East Asia accounts for most of the FDI outflows from the South, followed closely by South-East Asia and Latin America.8
- Over the past two decades, the sectoral composition of outward FDI from developing countries has changed significantly to be comprised of investments in manufacturing and services. Of this, large shares are directed at other developing countries. Estimates indicate that in the early 1990s almost three fourths of developing-country investments abroad went to the manufacturing sector, which accounted for 27 per cent of such FDI. Apart from manufacturing, services account for a large share of the FDI outflows from developing countries, much of which are directed at other developing countries. For instance, during the period 2008–2010, services accounted for nearly 70 per cent of such FDI, of which more than 55 per cent went to developing countries.

In sum, total FDI outflows from the South has increased, with a clear emphasis on the services and manufacturing sectors. Such a sectoral focus would normally imply a potential for technological learning. However, estimates indicate that FDI in sectors such as services and manufacturing originates mainly from emerging countries, particularly East Asian and South-East Asian countries, and is largely directed to those developing countries that possess strong production networks in these sectors or have the capacity to source such investments by virtue of their technological capabilities. This is true of a large share of the services FDI directed towards developing countries. FDI outflows targeting electronics and automobile industries are also directed towards East and South-East Asia, which have globally competitive production hubs. The FDI thus helps to cement and enhance the already existing technological capacity of these developing countries as part of existing production networks.

A large proportion of FDI outflows to developing countries that do not have significant technological capabilities such as the resource-rich developing countries (including African countries), go to their mining and natural resources industries. This form of FDI usually does not have direct technological impacts.[9]

III. THE POTENTIAL OF SOUTH-SOUTH COOPERATION FOR TECHNOLOGICAL LEARNING STILL NEEDS TO BE HARNESSED

Technological change and economic growth have a mutually reinforcing relationship in developing countries. Sustainable economic growth that is built on productivity increases in these countries does not fully rely on frontier innovations, as in industrialized countries, but rather, on the possibility to learn and build upon already existing technologies. This requires investment not only in manufacturing, but also across a range of activities that support overall industrial development, including in marketing, managerial and financial services, as well as in infrastructure and learning activities. This in turn increases absorptive capacity and the ability to adapt and apply existing technologies (in the form of products and processes) by means of local innovations, and thus leads to a gradual increase in productivity in all sectors. Such growth is intrinsically tied to how production structures evolve and what kinds of factors, policies and institutions enable the diffusion of technological knowledge to domestic sectors and firms.

However, much still needs to be done in order to harness this critical relationship in developing countries. For instance, an argument that has often been advanced is that the ongoing growth and shift in production patterns in some of the emerging countries, from low-end manufacturing to more knowledge-based domains, has opened up opportunities for other developing countries, particularly LDCs, to engage in low-end manufacturing. However attractive this might be, it does not occur automatically. To develop industrialization processes that could lead to a significant proportion of the total population being engaged in value-added production requires investments in building absorptive capacity. This necessitates a fundamental shift in the underlying conditions

of many developing countries, with a particular focus on factors that promote technological learning and innovation capabilities in those countries. Such a shift should be consistent with their comparative advantages and local demand. This challenge in leveraging technological learning through ongoing economic growth processes is demonstrated by the analysis of data and case study evidence in *TIR 2012*. The conclusions that lend strength to this observation are as follows:

- The empirical evidence on ongoing South-South technological exchange shows that the surge of economic growth in developing countries, particularly emerging countries, has been made possible in large part by their growing technological capabilities. This is reflected in the increase in their capital goods imports in recent times. Although capital goods imports by developing countries are growing, and are considered to be an indication of technological learning, the trends show that a large share of the capital goods exported and imported is concentrated in a sub-set of developing countries. These are countries that have some level of technological capabilities to integrate into GPNs, and their level of economic growth enables them to import capital goods. On the other hand, a large number of developing countries, particularly LDCs, are not major importers or exporters of capital goods.
- The growing manufacturing capabilities of a number of developing countries, particularly Brazil, China, India and South Africa, has enabled them to increase their exports of manufactured goods. It has also enabled them to participate in GPNs in both low-cost manufacturing and high-technology, value-added production. Moreover, globalization, as well as newer technologies and the move towards the knowledge economy, especially information and communication technologies (ICTs), have provided opportunities for these countries to use their existing skilled workforce to accumulate further knowledge and promote technological learning.
- FDI trends are similar to technological empowerment trends of the South, which tends to be concentrated in some countries, mainly East Asian countries as well as countries such as Brazil, China and India. Emerging countries account for the largest share of FDI outflows from developing countries, including through mergers and acquisitions (M&As) in the South. While South-South FDI outflows are directed to a variety of sectors, including services and health, they tend to be concentrated in specific activities involving exchanges among some countries in those sectors. This shows that a few developing countries are increasingly involved in mutually beneficial technological exchange.
- A review of case study evidence on South-South technological collaborations conducted in the Report10 shows that South-South inter-firm technology-related initiatives seem to be motivated mainly by economic considerations or proactive government incentives, or both. In contrast, South-South public sector and government-driven collaborations are more wide-ranging in nature, but at the same time they focus more on scientific and technical aspects rather than on technological collaboration or firm-level learning. There are also a variety of government initiatives for promoting technology exchange and learning, both regional and in the context of South-South relations, including the annual summits of the BRICS (Brazil, the Russian Federation, India, China South Africa) and the India, Brazil, South Africa (IBSA) forum. However, such initiatives could better serve the needs of developing countries if they specified ways and means of collaboration for technological capacity-building. Also, they should be more closely coordinated with government policy and projects within individual countries. Currently, the scientific and technical assistance programmes conducted by national agencies are often isolated from technological collaborations involving public and private sector organisations (that conduct joint R&D and training activities in specific scientific disciplines). In order to benefit the recipient countries, these need to be properly coordinated.
- While some South-South technological collaboration is evident, most countries are limited by the lack of intrinsic technological capabilities required to benefit more from ongoing South-South exchanges. Additionally, the South is contributing to an increasing commodity dependence of LDCs, which reduces their ability to structurally diversify their economies.11 While this is clearly an incidental effect of the economic boom in the emerging countries, there is a need to closely align the interests of all developing countries towards bridging the technological divide.
- The analysis further shows that in the countries that have been collaborating the most on technology and innovation, supportive national innovation environments have been contributing to building their technological capabilities. Within emerging countries, positive developments in factors such as R&D investments, education, patenting and licensing trends, the number of researchers per million people, infrastructure and ICTs are further strengthening their innovation capabilities.

These results point to two fundamental issues. First, ongoing South-South collaboration could potentially provide more opportunities for developing countries, including LDCs, to benefit technologically by leveraging the ongoing process of economic growth explicitly to promote technological change. For example, the analysis on FDI shows that despite its current regional concentration, South-South FDI could become more versatile in terms of its ability to be combined with capability-building approaches since it is largely concentrated in manufacturing and services. The rising share of FDI from developing countries into sectors such as services also creates opportunities for technological collaboration in these sectors, which is now currently not being fully harnessed.[12] A review of ongoing initiatives in this area shows that there are some interesting cases of scientific and technical collaboration, both public-sector-based and private-sector-led. But these too do not seem to demonstrate the full potential of South-South collaboration for technological learning and innovation.

While it could be argued that South-South technological collaboration is still in its initial phases, and therefore lacks coordinated efforts, it still seems appropriate to address the key challenge of fostering such collaboration systematically. This automatically leads to the second issue, namely, how to ensure that an appropriate level of emphasis is given to this by developing-country governmental initiatives and that the various platforms on South-South collaboration do in fact result in greater technological learning. This calls for measures that promote closer linkages between government agenda-setting and ongoing scientific and technological collaboration initiatives as well as inter-firm technological alliances within a broader framework of South-South collaboration.

IV. A FRAMEWORK TO PROMOTE SOUTH-SOUTH COLLABORATION ON TECHNOLOGY AND INNOVATION IS NEEDED

In order to effectively address these issues, *TIR 2012* proposes a set of principles around which a framework of South-South collaboration for technology and innovation can be structured. Such a framework must be able to address the challenges identified in this Report. To begin with, short-term objectives of trade openness and the imports of inputs for industrialization processes should be consistent with longer-term technological development goals of the developing world as a whole. A framework on South-South collaboration could therefore help to align the interests of all developing countries in this highly relevant area. Moreover, although technology and knowledge are key inputs to catching up (and convergence) processes through which developing countries absorb ideas and concepts from the industrial frontier, the accumulation of technological capabilities will not be possible without express policy and institutional support by the international community and by the developing countries themselves. Therefore, as part of such a framework, *TIR 2012* proposes that developing countries strengthen their cooperation with a particular focus on *collaboration for technology and innovation*. A framework that promotes interaction at three different levels is suggested:

- Exchange of experiences in policy-making and in devising policy frameworks for technology and innovation;
- Technology exchange and flows aimed at increasing the technology absorptive capacity of the private and public sectors; and
- Transfer of technologies in key sectors of importance to public well-being, such as agriculture, health, climate change and renewable energy.

Such a framework for South-South collaboration on technology and innovation needs to move beyond priority setting and political declarations; it should propose a clear road map for action. The Report articulates a set of principles that could form the basis for such an international framework. These principles are derived from some important issues prevailing in the context of technology and innovation exchange globally and among developing countries. These are discussed briefly here.

1. The technological needs of all developing countries should be better integrated into ongoing South-South exchange (principle 1)

Closing the gap between formal and informal production structures in a large number of developing countries, particularly LDCs, and promoting domestic capabilities calls for more proactive engagement in addressing their technological needs in a coherent and dynamic way. This form of engagement not only necessitates greater investments in tertiary education, skills training and competence-building within countries; it also needs to be reinforced by enabling greater access to knowledge and technological capacity-building through, for example, inter-firm cooperation, joint ventures and licensing agreements. Support for knowledge-based activities in developing countries is therefore essential for transforming their economies towards activities that focus on greater value addition and higher returns on investment.

2. The experiences of developing countries in building innovation capabilities should be shared more proactively (principle 2)

Emerging countries have pursued a variety of industrial and development policies and strategies to promote technological catch-up. Innovation policies are essential components of such strategies. Innovation policy frameworks can be understood as purposive actions and incentives provided by governments to promote interactive learning and collaboration among all economic and non-economic actors in the system. Such policies have been instrumental in overcoming market imperfections that obstruct technological change, and which are pervasive and widespread, particularly in developing countries. Sharing these policy experiences is relevant for two main reasons. To begin with, they are useful in order to glean general lessons and derive best practices on how developing countries can best promote economic catch-up. Secondly, they can also be highly instructive in deriving policy options for promoting linkages between various aspects of innovation frameworks. Whereas all measures will not be applicable in all countries universally, sharing these experiences would provide an array of policy options for developing countries that could be pursued for investment promotion, linking IPR protection to innovation policy, linking enterprise development with innovation policy, and coordinating research between universities and industry, among others.

3. Learning needs to be promoted through South-South alliances and technology transfer (principle 3)

A critical shift in South-South collaboration on technology and innovation is needed, with a focus on promoting technological learning based on the South's own rich and diverse experiences, as highlighted in the Report. Some of the means of such learning, such as technology transfer, have been demanded by developing countries in the international discourse for decades. Technological development implies more than just promoting the import of technologies through FDI or trade in capital goods. As mentioned above, what is more crucial is the building of capabilities through skills development and the transfer of operation and maintenance know-how which promotes technological progress.

Mechanisms for technological collaboration have traditionally focused on a North-South dimension, but there are also opportunities to develop South-South mechanisms for the sharing of experiences on technological capacity-building and transfer. Indeed, these could be particularly appropriate in the developing-country context, given that these countries share common development challenges. Such mechanisms could complement ongoing efforts to foster North-South technology transfer by placing an explicit emphasis on technological learning and building local capacities for innovation. One such mechanism is the creation of strategic technological alliances between some developing countries, particularly the emerging countries on the one hand, and other developing countries, on the other, to promote learning in sectors that already have some level of domestic technological capabilities. Technology transfer and the sharing of tacit know-how is another instrument that the South could use to pioneer different solutions by leading by example.

4. FDI needs to be more technology-oriented in order to support the building of technological capabilities (principle 4)

Many countries have leveraged FDI to promote the absorption of technologies and building of innovation capacity. The Republic of Korea is an example of a country that has sought to use FDI as a source of technology within its overall industrial development strategy. There are instances where South-South FDI has had positive results in terms of building national technological capabilities. Interesting examples of how governments have promoted the transfer of tacit know-how by the foreign investing firm to a local partner are those of Uganda and Ethiopia.[13] These cases show that FDI can be combined with a variety of other policy measures. However, on a general scale, there is often a disjunction between innovation policies and FDI policies in countries. This disjunction needs to be addressed through an innovation policy framework that allows recipient countries to realize the potential of FDI for technological learning.

5. Developing countries should pool technological resources to address common challenges (principle 5)

There are a range of development challenges that confront all countries of the South to varying degrees. They need technological innovations and platforms that promote a smoother transition towards a green economy, help address climate change mitigation and adaptation, encourage the use of sustainable energy and renewable energy technologies, as well as help improve public health and food security. For all these technological challenges, common responses could be forged.

In all these areas, the level of domestic firms' capabilities in many developing countries is insufficient to support the creation of conventional forms of technological alliances. Therefore, there is a need for new alliances that enable the development of particular kinds of technologies that are of critical importance to the developing

world. Developing countries could also help the sharing of already existing knowledge in important sectors and industries, which until now has not been systematic. Instead, there is a continued reliance on North-South exchanges in finding technological solutions.

Not only are developing countries' experiences in building innovation capacity particularly relevant for bridging the technological divide, their technologies are also often more locally adaptable in other developing countries, including LDCs, owing to similar contexts, and hence they are more appropriate for those countries.

V. EXPLICIT POLICIES ARE REQUIRED TO SUPPORT THE EMERGENCE OF SUCH A COLLABORATIVE FRAMEWORK

Current discussions on technology and innovation in the international context often revolve around how international commitments for technology dissemination and transfer can be fostered.[14] Within several of these discussions, such as those related to Article 66(2) of the Agreement on Trade Related Aspects of Intellectual Property Rights (the TRIPS Agreement), consensus still needs to be reached on defining and measuring technology transfer. While these discussions remain important from an overall global perspective, this Report articulates a number of policy measures that could be implemented at the national, regional and international levels in order to operationalize the principles outlined above.

The policy measures identified by this Report are not exhaustive, but help to show the way forward. Moreover, they should not be construed as binding developing countries, particularly emerging countries, to exacting technological commitments. The policy measures suggested here are meant to facilitate South-South technological collaboration through long-term-oriented institutions in all developing countries, whether they act as suppliers or recipients of technological knowledge in collaborative ventures.

1. Closely link national innovation policies to South-South initiatives

National innovation policy frameworks could be accompanied by the following policy measures specially aimed at encouraging South-South collaboration for technology and innovation.

a. Coordinate local and regional innovation policies with South-South initiatives

There is often a disconnect between national and regional policies on technology and innovation. Furthermore, since some developing countries have only recently emerged as significant sources of technological learning, many existing policy instruments do not expressly refer to South-South collaboration in this area. This needs to be revised in policy setting exercises, both at the national and regional levels, to reflect the new reality, recognizing developing countries as long-term partners in technological capacity-building.

As part of this, innovation policy frameworks at the national and regional levels need to be revised to incorporate certain key innovation priorities in South-South transactions. A range of policy measures could be implemented to expressly promote South-South technological collaboration, including, but not necessarily restricted to:

- Linking developing-country FDI with clearly articulated technology and tacit know-how requirements;
- Providing/using existing government funding to promote scientific and technical collaborations for priority sectors between developing countries (in their region or even outside the region);
- Granting special incentives and tax reductions to local firms in return for entering into joint ventures or joint production arrangements with firms from developing countries, with a particular emphasis on acquiring technologies;
- Offering incentives to foreign firms from developing countries, particularly emerging countries, such as special tax cuts or government procurement assurances, in return for setting up production facilities and transferring know-how to local firms;
- Providing technology incubation facilities to support new technology applications in local industry with help from firms in developing countries, particularly emerging countries.

b. Provide incentives for shifting towards higher value-added activities

In order to minimize the risk of local firms remaining at lower ends of GPNs with few or no chances of moving up the value-added stages of production, there is a need for explicit policy measures that support engagement in higher value-added activities. Higher value-added activities in this context are closely associated with, but not identical to, manufacturing although this sector is certainly essential for driving structural transformation. The notion of higher value-added should also encompass greater social value added through innovation activities, which essentially relate to ensuring that innovation activities respond to local needs and also foster equitable and inclusive development and are pro-poor. Innovation funds, both at the national and sectoral levels, could help to induce such a shift towards increased value added, particularly in countries rich in natural resources.

c. Focus on technological learning in policies of emerging countries

In order to ensure that technological learning is an essential component of South-South interactions, emerging countries could introduce policy measures that help to increase the focus on collaborations in mutually beneficial technologies and innovation. These could take the following forms:

— Adopting policies that promote technological engagement with other developing countries from a long-term perspective; and

— Providing additional incentives to national firms to engage in technological exchange and the building of tacit know-how in firms in other developing countries.

2. Adopt policies that promote a long-term technological orientation

The overall technological development of the South is a common good that will have positive network effects for all developing countries and their policy strategies need to reflect this. Their long-term vision and strategy should

Box 1: Institutional features of the proposed South-South Innovation and Technology Pact (SITEP)

The SITEP would support technological learning and innovation capacity across all developing countries by providing institutional support at three different levels through a variety of policy instruments. At each of the levels, institutional support could take the following forms.

(i) Promote technological learning at the firm level.

A number of developing countries, in particular emerging countries, are increasingly producing new, state-of-the-art technologies. Many of these efforts are being financed by public investment. Three instruments could particularly advance access to and production of such knowledge:

- Pooling public investment for basic R&D: Such a mechanism would pool together public investment for basic R&D across developing countries that seek to join hands as a means of promoting both the development of domestic learning capabilities as well as linkages and interactions among actors in innovation systems across themselves. This could be done at a regional level, or amongst countries that choose to partner across regions.
- South-South research and product development hubs: Regional R&D facilities to create and sustain R&D within firms or those which provide R&D services on a pay-as-you-go basis could constitute an important short- and medium-term solution to some of the major problems faced by public and private sectors in developing countries.
- South-South pooling of supply and demand: A major impediment to many technological innovations is the limited or lack of local/regional market demand. This is particularly true in industries where technological innovations are investment-intensive and risky, such as in health technologies. This mechanism would fill that gap by pooling demand regionally or across like-minded countries that have similar needs within the South.

(ii) Promote enterprise development and financing of specific innovation activities that are of particular importance to developing countries as a whole.

The proposed SITEP would have a second set of policy instruments and activities that are directly geared to alleviating many of the constraints faced at the enterprise level, including financing that could take various forms as discussed below:

- Venture capital funding at the regional level: Emerging enterprises in LDCs that show promise in key sectors of regional importance, such as pharmaceuticals, agro-processing and ICTs, could be provided with venture capital funding. Such funding programmes could offer awards through contests for participating regional firms.
- Co-investment with private investors in innovative enterprises: A number of schemes could be launched at the regional level for the development of early-stage innovative technologies by local firms. Acquisition of technological know-how could be supported through public-private/private-private partnerships between various developing countries.
- Financing for collaboration between private and public enterprises: Such an instrument could expressly address the lack of incentives at the national/sectoral levels in developing countries so as to enable collaborative linkages.

(iii) Act as a platform for sharing innovation experiences and promoting policy learning.

Developing countries could benefit enormously from building a common forum for exchange of information about their national technology and innovation policies. Such a forum would enable the sharing of experiences on how countries could promote industrial development within the parameters of the international trade and IPR regimes. The forum would provide a venue for discussions on the options and flexibilities that are still currently available under the existing international rules which, overall, can often be restrictive.

The SITEP could be augmented by regional initiatives directly aimed at building innovation capacity at the regional level.

Source: UNCTAD.

contain clear targets and milestones to be achieved in terms of technological collaboration.

a. Adopt policies that link technical and scientific cooperation with technological collaboration

As the Report shows, although many developing countries are actively engaged in expanding their technical and development assistance activities, there is a lack of coordination between scientific and technical collaboration provided by their agencies and the ongoing technological collaborations between firms. In order to ensure the best results, these activities should be better coordinated by means of a clear policy on South-South technological collaboration set out by the governments. Emerging countries, in particular, need to articulate long-term strategic objectives as suggested in the aforementioned section.

b. Provide incentives to firms for technological collaboration and technology transfer

Emerging countries could provide greater incentives for technological collaboration and transfer of technology within their policy frameworks. These incentives could take the following forms:

- Tax concessions to emerging-country firms in return for entering into or attracting joint ventures or joint production arrangements with firms in developing countries, particularly LDCs;

- Grant local firms special "development-friendly" certificates as a goodwill gesture. These can add to the corporate image of the firms and help them to develop a customer base across the South.

3. Operationalize the South-South Innovation and Technology Pact (SITEP)

In order to facilitate a common, development response to these issues, this Report suggests the pooling of technological resources by developing countries through a comprehensive South-South Innovation and Technology Pact (SITEP). The proposed pact would be a mechanism that seeks to coordinate and promote a developing-country response to technology-related issues. The SITEP should provide institutional support at three levels. To begin with, it could promote technological learning at the firm level as an essential complement to ongoing South-South scientific cooperation and technical assistance programmes. At a second level, it could promote enterprise development and financing of specific innovation activities that are of particular importance to developing countries. Finally, it could act as a platform for sharing innovation experiences and promoting learning at the policy-making level (box 1).

Given the similarity of developing countries' innovation experiences and their technological strengths, the Report recognizes these countries as natural strategic partners with each other in efforts to bridge the technological divide. Furthering this role requires creating the right basis for accessing science, technology and innovation resources within the developing world. The technology and innovation resources of the South will be critical for linking firms and organizations across developing countries, particularly LDCs, with the global knowledge economy to accelerate their development processes. This needs to be based on an understanding that: (a) innovation is a multidirectional, highly interactive process that integrates or "articulates" science, technology and production, and (b) new policy thinking is needed to help establish virtuous circles of rising productivity, technological progress and structural transformation across the entire developing world.

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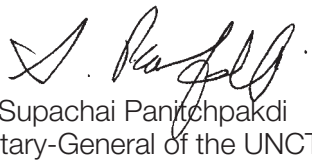
There are many outstanding issues concerning technological learning and innovation capacity in the context of developing countries, including those related to technology transfer, which need to be addressed at the international level. Developing countries can lead the way by working together and providing constructive solutions to these unresolved policy challenges in the coming years.



Geneva, October 2012

Supachai Panitchpakdi
Secretary-General of the UNCTAD

NOTES

1. Referred to as the "East Asian miracle", the first-tier newly industrializing economies (NIEs) that followed Japan's industrialization comprised Hong Kong, the Republic of Korea, Taiwan Province of China and Singapore, and the second-tier comprised Indonesia, Malaysia and Thailand.
2. See box 3.2 in chapter III. Some other studies such as UN-ECOSOC (2008) quote higher figures. This reflects the considerable variation in the quality and availability of data from the four major contributors from the South – the Bolivarian Republic of Venezuela, China, India and the Republic of Korea. Furthermore, this figure may underestimate total development assistance by the South, since several smaller bilateral and multilateral contributions were not included in the study due the paucity of data and differences in definitions of what constitutes development cooperation.
3. See annex table A.II.6 of the Report.
4. Annex table A.II.11.
5. These trends are captured in figure 2.8, chapter II, which shows a large gap in the imports of machinery and transport equipment between oil-exporting LDCs, non-oil exporting LDCs and other developing countries.
6. Table 2.7 and figures 2.9 and 2.10, chapter II.
7. Table 2.7, chapter II.
8. Table 2.8, chapter II.
9. Table 2.9, chapter II.
10. Chapter III.
11. Trends in exports of primary commodities show that while LDCs exported their primary commodities mainly to developed countries, this pattern has shifted significantly towards developing countries since 2003 (figure 1.5, chapter I).
12. Table 2.9 and figure 2.12 in chapter II show that the services sector accounts for over 50 per cent of all FDI from developing countries.
13. These examples are discussed in chapter III of the Report.
14. See box 4.8 in chapter IV for a discussion.

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THE IMPORTANCE OF THE SOUTH

CHAPTER I
THE IMPORTANCE OF THE SOUTH

A. BACKGROUND

The past decade has seen a dramatic rise in the political and economic significance of some countries of the South, particularly Brazil, China, India and South Africa. Their rise is part of an ongoing but punctuated process of catch-up growth and development which began with the rapid industrialization of the first- and the second-tier East Asian economies in the 1960s and 1970s.[1] The recent rise of countries in the South during the last decade has, by contrast been much more widespread, including in Africa, with the anticipation that new growth poles, such as Egypt and Nigeria, will continue to emerge over the coming years (O'Neill and Supnytska, 2009).

Sustained growth and economic expansion of a number of these countries has been made possible by interrelated factors, including their growing capabilities in manufacturing and services, technological investments and efficient utilization of opportunities arising from globalization. Together with rising per capita incomes and the concomitant growth of domestic demand, these factors have helped to consolidate cumulative linkages on both the supply and demand sides of the economy, which have helped to underpin the strong growth performance.

Steady economic growth in these countries has also translated into an increase in South-South cooperation in trade, investment and technology over the past two decades, enabling them to become significant global trading partners with other developing countries in the 2000s (tables 1.1 and 1.2). Current trends of enhanced South-South cooperation are in line with the political aspirations of the developing countries dating back to the 1950s, when they undertook a series of political initiatives to collectively change the terms of their engagement in global processes in an effort to further their development (box 1.1). These initiatives led to formal recognition by the global community of the need to support technical cooperation among developing countries.

The rise of the South… is part of an ongoing but punctuated process of catch-up growth and development.

At that time, however, these countries did not have the requisite economic and other structural capacities they now have to support and expand South-South cooperation. Given the rapid progress made by some developing countries, there has been a renewed interest in how they could improve cooperation among themselves in trade, investment and technology to further promote growth and to ensure strong gains from the closer integration of the South in the global economy. Growing disappointment in a variety of international forums for trade, technology and development, including the Uruguay Round of trade negotiations (Shafaeddin, 2010), has also prompted a revival of interest in South-South cooperation as a means of addressing critical development issues.

Ongoing South-South cooperation extends far beyond simple economic linkages. Population growth in some of the emerging countries, particularly China and India, is another important factor explaining rising South-South trade and investment trends. Some developing countries, along with their growing economic clout, have widened their geopolitical horizons for reshaping the global governance architecture. These are, in part, reflected in their increasing contributions to development cooperation and assistance. Recent studies estimate that development assistance from developing countries has been growing steadily, reaching $7.3 billion in 2010 (OECD, 2010).[2]

Ongoing South-South cooperation extends far beyond simple economic linkages.

In an effort to further their geopolitical aspirations, newer alliances are also being

Box 1.1: A brief history of South-South cooperation

The Bandung Conference of 1955 was the first major initiative in South-South cooperation, where 24 countries from Asia and Africa met on a common platform to promote economic and cultural cooperation "on the basis of mutual interest and respect for national sovereignty".[a] This Afro-Asian Conference was followed by a much larger initiative by the countries of the South to assert their right to development through the non-aligned movement (NAM), which convened its first meeting in 1961. The major concerns of NAM were the "protection of the sovereignty and rights of small underdeveloped states and their development in freedom". Perhaps its most significant contribution was that its members aspired to achieve "collective self-reliance", which to this date remains the strongest statement of South-South cooperation.

Between 1972 and 1977, the General Assembly of the United Nations, driven by the action of NAM and the Group of 77 developing countries (G-77), adopted a series of resolutions calling on the United Nations system to assist developing countries in their efforts to increase technical cooperation among themselves. The General Assembly responded by deciding to establish a working group to formulate recommendations on technical cooperation among developing countries (TCDC); set up a special unit within the United Nations Development Programme (UNDP) to promote TCDC; convened a high-level special session devoted to development and technical cooperation; and inscribed TCDC as a permanent item on the agenda of the General Assembly (UNDP, 1994).

In 1974, developing countries proposed the Declaration for the Establishment of a New International Economic Order (NIEO) at UNCTAD. These proposals were aimed at promoting developing-country interests and creating an intergovernmental forum for North-South dialogue and negotiations on this issue. The NIEO as a call by developing countries to belong and be treated as an integral part of the global order (Corea 1977: 177-178). Subsequently, intergovernmental meetings at the UN, including UNCTAD, attempted to create an international framework that is more conducive to the development process.

The first United Nations Conference on Technical Cooperation among Developing Countries in 1978 adopted the Buenos Aires Plan of Action for promoting and implementing technical cooperation (also known as BAPA). As such, BAPA provided the first major blueprint for TCDC. It offered a new orientation to development cooperation with its emphasis on national and collective self-reliance among developing countries as the foundation for a new international order. BAPA was endorsed in 1978 by General Assembly Resolution 33/134, which cleared defined TCDC. This became the basis for a series of regional intergovernmental initiatives in the 1980s onwards (see chapter III).

Source: UNCTAD, based on various sources.

[a] *Final Communiqué of the Asian-African Conference of Bandung, 24 April 1955, available at: http://franke.uchicago.edu/Final_Communique_Bandung_1955.pdf.*

forged among countries. This is exemplified by the BRICS – Brazil, the Russian Federation,[3] India, China and South Africa – and IBSA – India, Brazil and South Africa – groups of countries that have served as platforms for an extended South-South discourse. These countries, for instance, have intensified their individual and joint development cooperation with other countries of the South, as evident in their annual summits that have been held since June 2009.[4]

This signals the beginning of a new era in global development, with a shift from a hitherto bipolar development dynamic to a potentially more pluralistic.

Over the three decades, from 1980 to 2010, the rates of growth of gross domestic product (GDP) have varied widely across regions and countries. Despite the uneven growth performance across developing countries over the past three decades (table 1.1 and figure 1.1) and growing income gaps, the recent surge in growth in an increasing number of developing countries signals the beginning of a new era in global development, with a shift from a hitherto bipolar development dynamic (which was predominantly North-South) to a potentially more pluralistic one (North-South-South).

As a result, there is a real potential for a new paradigm for international development to emerge, which extends the existing boundaries of engagement to include those developing countries – particularly least developed countries (LDCs) – that are currently marginalized in the global economic system. Realising that potential will require significant changes in the way the global economy is governed, to make it more development-oriented and a burgeoning literature, supported by growing empirical evidence, has already highlighted the potential merits of increasing South-South trade and investment.

Table 1.1: Real GDP growth rates, 1980–2010

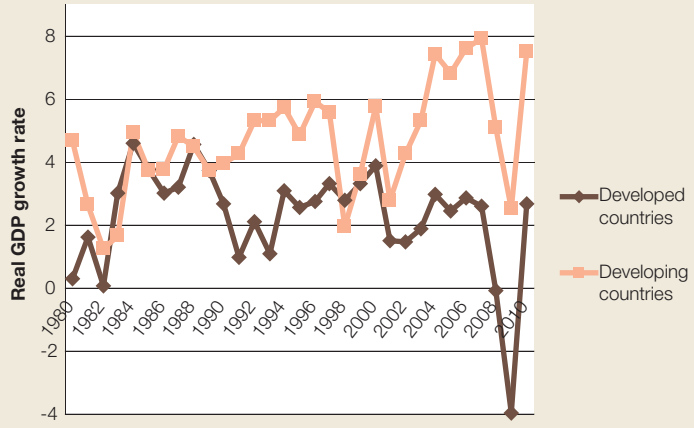
	1980	1990	2000	2005	2010
Developed countries	0.30	2.65	3.88	2.45	2.66
Developing countries	4.68	3.96	5.78	6.80	7.48
Africa	3.59	2.64	3.46	5.45	3.99
Latin America and the Caribbean	6.31	0.52	4.41	4.58	5.98
Asia	3.63	6.48	6.79	7.87	8.44
East Asia	4.98	5.75	8.11	8.63	9.53
South Asia	0.96	6.51	4.04	8.24	7.14
South-East Asia	6.37	8.33	6.15	5.80	7.99
West Asia	2.93	6.55	6.43	6.86	6.36

Source: UNCTADstat.

Note: For all calculations, South Asia comprises: Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka. East Asia comprises: China, Democratic People's Republic of Korea, Hong Kong (SAR of China), Macao (SAR of China), Mongolia, Republic of Korea, Taiwan Province of China. South-East Asia comprises: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, Lao People's Dem. Republic, Philippines, Timor-Leste, Vietnam. West Asia comprises: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Turkey, Yemen. Latin America and the Caribbean comprises: Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guyana, Haiti, Honduras, Jamaica, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela. Southern Africa comprises: Botswana, Lesotho, Namibia, South Africa, Swaziland.

There is a real potential for a new paradigm for international development to emerge.

Figure 1.1: Real GDP growth rates of developed and developing countries, 1980–2010 (Per cent)



Source: UNCTADstat.

However, the analysis remains general, and data on some other important issues are scarce or not easily available. One such issue concerns technological flows and collaboration of the kind that can build innovation capabilities in developing countries as a whole.

Against this background, this *TIR 2012* argues that the time is ripe to move beyond analysing current trends in South-South trade and investment and begin conceptualizing on how and to what extent South-South cooperation could help address specific development goals of developing countries. One such goal is to bridge the technological divide so as to promote industrialization and inclusive globalization within the developing world as a whole.

Rising South-South trade and investment trends have been viewed positively as a signal that the developing countries could provide a significant impetus to the development of the other developing countries.

B. SOUTH-SOUTH COOPERATION: KEY ARGUMENTS

A review of the existing literature on South-South cooperation and regionalization shows that from the outset the discourse has been largely centred on South-South trade and investment, and how it could contribute to industrialization of the countries involved. In much of the analysis, rising South-South trade and investment trends have been viewed positively as a signal that the developing countries could provide a significant impetus to the development of the other developing countries. The literature identifies two main positive aspects of cooperation between countries of the South:

i. Such cooperation would help the South to decouple from the global cyclical trends of growth, thereby promoting a new form of stability in the global economic system; and

ii. Since the emerging countries are still in their development phase, they are better placed to understand the problems of development, particularly in the current global context, and could provide a new model for cooperation and technical assistance.

These views are discussed in greater detail here.

1. Growing South-South trade and its implications

Already in the 1950s, development economists advocated increased South-South trade as an important means to overcome constraints linked to limited domestic resource mobilization and the small size of the local market (e.g. Myrdal, 1956; Lewis, 1979). These continue to be critical issues for many developing countries even today. South-South cooperation and regional integration were also considered an important means for promoting industrialization (ECLA, 1950; Prebisch, 1984). Here, the arguments for greater South-South interactions have linked increased trade to building productive capacities through the establishment of a "vent-for-surplus", which recognizes that there are many unutilized productive resources in developing countries, including labour, which could be put to use through increased South-South trade. This view was the basis for a variety of regional trade agreements between developing countries that were concluded in the 1960s and the 1970s. However, later studies showed that these agreements did not succeed in increasing South-South trade (see, for example, de Melo and Panagariya, 1993).[5]

At the same time, counter perspectives on South-South trade expressed scepticism over replacing market-based "welfare maximizing patterns" of trade with induced preferences accorded to trading partners through preferential trading arrangements (PTAs). It has been argued that such PTAs reduce welfare because, unlike market-induced trade that gives priority to lowest-cost producers of goods, the PTAs may favour higher-cost producers over potential low-cost ones and lead to distorted trading patterns (see, for example, World Bank, 2000). More recent literature on South-South trade has focused largely on the possibility of decoupling, convergence and the "flying geese" hypothesis (boxes 1.2 and 1.3).

Box 1.2: The flying geese hypothesis

The flying geese hypothesis, based on the works of Akamatsu in Japan in the 1930s, shows the sequence of catching up of late-comer economies with other already developed ones. It posits that, based on complementarities in production processes, a process of dynamic comparative advantage would enable a structural transformation of developing countries from being importers of goods to producers and exporters of the goods, thereby causing them to gradually converge or catch up with more advanced countries (Akamatsu, 1962). The flying geese metaphor reflects the "V" shape of flying geese inversely where one or some lead countries could, through their processes of structural transformation, create opportunities for others to follow.

In the flying geese hypothesis, the first stage is marked by an intra-industry process by which a country changes from being a net importer of goods in a sector to a local producer and eventually an exporter of goods in that sector. This graduation from imports to local production and then to production for exports (which is marked by increased imports of capital goods that feed into the expansion of local production) is a fundamental element of a country's development path, according to this hypothesis. A second stage is the dynamic expansion of capabilities from this lead sector into other sectors of the economy (through technological spillovers and a wider use of the skills base). This stage is critical, denoting the process of structural change in the economy, whereby industries in a variety of sectors are developed and a rising level of capabilities in the country is directly reflected in the technological sophistication of the goods produced. A third and final stage is the relocation of industrial activities to other countries through a process of gradual convergence.

Source: UNCTAD.

Box 1.3: Decoupling and reverse coupling

Reviews of the economic performance of countries from the 1950s show clear cyclical dependencies and linkages between the growth of the developing and developed countries, where the growth rates in the former have been "coupled" with the growth of the latter. In recent years, the rapid rise in growth rates of several developing countries has led to what is widely known as the "decoupling hypothesis", that is, the possibility that with significant growth rates, developing economies can delink their economic growth from the cyclical patterns of dependence on the developed economies.

However, despite significant growth rates in the South, there has been no evidence of any imminent decoupling. At the same time, the quicker recovery of financial markets in some of the developing economies from the most recent global financial crisis (O'Neill and Supnytska, 2009) has led to a prediction of "trend decoupling", whereby the emerging countries are at least partially decoupled from the cyclical boom-bust growth patterns of the global economy. Whether or not this is ongoing is not fully clear. Many developing countries have been less vulnerable to the crisis due to their burgeoning domestic markets, but still rely largely on exports from several sectors.

A related issue that has been explored in the literature is that of convergence, which envisages economic convergence between the rising developing countries and the developed countries. Scholars warn that while convergence is a possibility, there is no clear indication that this will necessarily take place (Rodrik, 2011). Just because some of the rapidly growing economies of the South have converged towards the developed countries does not mean that other developing countries will or could follow a similar path. At the same time, studies note that a major reason for the better performance and speedy recovery of the larger developing countries has been robust domestic demand, which has been a key factor in reducing their vulnerability to the impacts of the global economic crisis.

Source: UNCTAD.

Data on trends in South-South trade show that intra-South trade has increased quite significantly since the mid-1990s (table 1.2; see also table 2.2 in chapter II). In 1995, 42 per cent of the trade of developing countries was with other developing countries, and by 2010 this figure had reached 56 per cent.[6] However, a significant aspect of South-South trade is that its importance varies considerably both intra-regionally and inter-regionally. Among country groups, South Asia and South-East Asia have the highest proportion of intra-South trade, amounting to approximately 64 per cent of their total trade. Amongst individual countries, India has the highest share of intra-South trade (table 1.3 and also figures 1.2 and 1.3). Currently at 66 per cent, India's trade with its developing-country partners are much greater than those of either Brazil or China (table 1.3). Most importantly, for all the regions and countries included in table 1.1, South-South trade was more

Intra-South trade has increased quite significantly since the mid-1990s…to reach 56% of total trade in 2010.

Table 1.2: Evolution of trade by region, 1995 and 2010 [a,b] (Percentage of total trade)

	Economy					
	Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
	1995	1995	1995	2010	2010	2010
Developing countries	41.58	57.64	0.78	55.82	41.88	2.31
Latin America and the Caribbean	28.91	70.10	1.00	40.42	58.45	1.13
Southern Africa	59.21	40.64	0.15	52.93	46.60	0.48
South Asia	41.22	56.37	2.41	64.74	32.53	2.73
South-East Asia	44.91	54.64	0.45	64.63	34.42	0.95
East Asia	46.04	52.90	1.06	56.33	41.23	2.44
West Asia	38.20	59.69	2.11	55.48	41.29	3.24

Source: UNCTADstat.

[a] *The figures presented in the table add up to 100 per cent for each of the years, 1995 and 2010.*

[b] *Also see annex table A.II.8.*

Table 1.3: Evolution of trade of selected developing countries, 1995 and 2010 [a]

	Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
	1995	1995	1995	2010	2010	2010
Brazil	37.78	61.31	0.92	53.16	44.51	2.33
India	39.82	57.97	2.21	65.31	32.69	1.99
China	49.01	49.24	1.74	49.91	47.02	3.07
South Africa	..	..	..	53.33	46.18	0.49

Source: UNCTADstat.

[a] *The figures presented in the table add up to 100 per cent for each of the years, 1995 and 2010.*

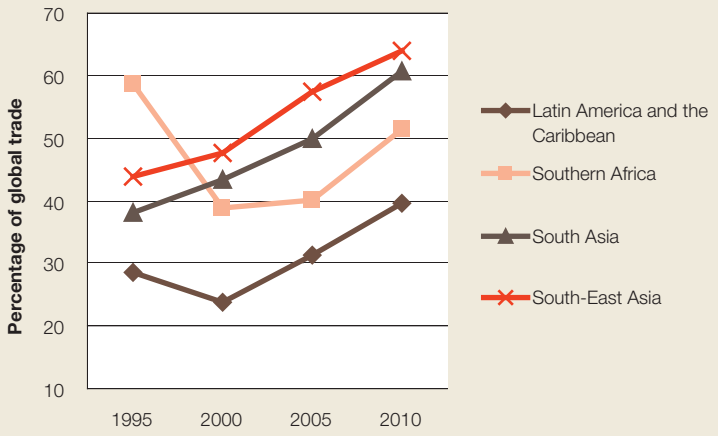
The importance of developing countries, particularly those in Asia, as sources of FDI has increased quite significantly.

important than South-North trade, except for the Latin American and Caribbean region.[7] This growing South-South trade as a result of the overall growth trends in developing countries is also leading to a larger number of regional trade agreements between developing countries.

2. South-South investment as a driver of development

Historically, foreign direct investment (FDI) has been an important source of financing and capital in developing countries. The importance of developing countries, particularly those in Asia, as sources of FDI has increased quite significantly over the past two decades.[8] This rise has been all the more steep since the peak of the global financial and economic crisis in 2008. The share of developed countries in total global FDI outflows declined, from 94 per cent in 1980 to 68 percent in 2010, whereas that of developing countries increased from 6 per cent in 1980 to 28 per cent in 2010 (figure 1.4). Countries such as China and India accounted for a large share of this increase.[9]

Figure 1.2: Evolution of trade of different regions with the South as a share of their total trade, 1995–2010 [a]

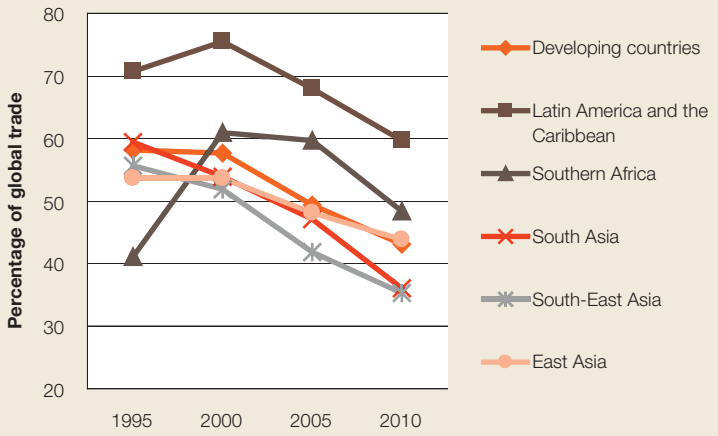


Source: *UNCTADstat.*

Note: *For the country composition of each of the regional groupings, see note to table 1.1.*

[a] *Figure shows the increase of trade between different regions of the South and developing countries as a whole as a percentage of total trade.*

Figure 1.3: Evolution of trade of different regions with the North as a share of their total trade, 1995–2010 [a] (Per cent)

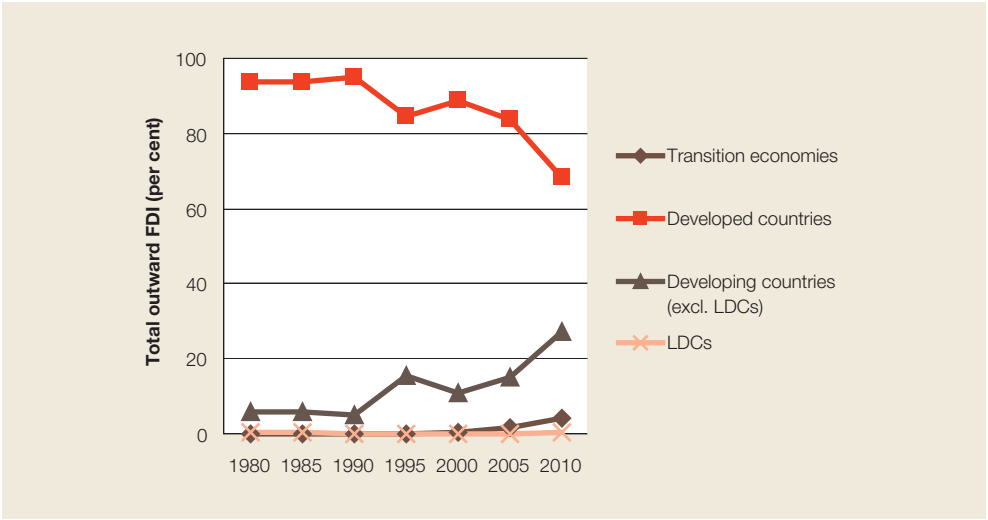


Source: *UNCTADstat.*

Note: *For the country composition of each of these regional groupings, see note to table 1.1.*

[a] *Figure shows the decrease of trade between different regions of the South (as well as developing countries as a whole) and developed countries as a percentage of total trade.*

Figure 1.4: Share of FDI outflows from developing countries in total global FDI, 1980–2010 [a] (Per cent)



Source: UNCTADstat.

[a] *Figure shows share of FDI outflows from developing countries in comparison with developed countries and transition economies.*

The attraction of FDI is linked to technology diffusion and knowledge accumulation.

The attraction of FDI is not, however, linked only to the scale of capital flows but includes a package of other tangible and intangible benefits, of which the most important are linked to technology diffusion and knowledge accumulation. Evidence of technology transfer through supply chains of transnational corporations (TNCs) from industrialized countries to East Asian economies and more recently also to some of the other emerging countries is well documented in the literature.[10] FDI in productive sectors also has a chain effect resulting in productivity gains in other sectors, as demonstrated in Colombian manufacturing or in Costa Rica (Kugler, 2000; Blalock and Gertler, 2008). However, the role of FDI in building productive capacity cannot be generalized, especially if investment does not go to productive sectors of the economy. This remains a problem in a number of developing countries, particularly LDCs, where FDI tends to be concentrated in natural resource exploitation and creates "enclave" economies.[11]

The rise of emerging countries as a source of FDI gives host countries a wider choice of partners for alternative sources of finance.

The rise of emerging countries as a source of FDI gives host countries a wider choice of partners for alternative sources of finance. Such a choice, if accompanied by supportive host-country policies and infrastructure development that promote investment in productive sectors, allows a greater range of foreign investments in a wider variety of industries with positive implications for capacity-building. FDI can lead to technology spillovers when the TNCs bring new kinds of product and process technologies to the host countries.

Although these effects may not be uniform in different contexts, various studies suggest that in countries that have a minimum level of domestic capabilities and a policy framework that promotes linkages, tacit know-how acquired by local workers in the TNCs can lead to spin-off activities that involve technological learning (UNCTAD, 2010). A number of studies have noted that the tendency of developing-country TNCs to enter into joint ventures with firms from other developing countries is greater than that observed among developed-country TNCs (UNCTAD, 2006a), and that this enhances the potential to foster learning capabilities (see chapters III and V of this Report for some examples). This could also be attributed to the varying forms of corporate governance in large companies in developing countries (see chapter IV).

C. THE IMPORTANT ROLE OF THE SOUTH IN TECHNOLOGICAL LEARNING AND INNOVATION

Current growth trends, and the related expansion of South-South trade and investment has created an interest in how and to what extent developing countries could help build technological capabilities in the developing world. But the literature on this aspect of South-South cooperation is quite scarce, and generally focuses on pressing international challenges, such as public health and climate change.[12] Internationally, however, this remains a critical issue where much more needs to be done, especially in the context of the widening technological divide and growing concerns about the global intellectual property rights (IPR) protection regime and how it limits the possibilities for the poorest developing countries to design their catch-up strategies.[13]

In the classical development economics discourse, economic growth is considered to be a process of related factors that shift the production structure of economies. Overall productivity increases as a result of these shifts in the production structure that result from a series of interlocked processes, namely, capital accumulation, technological change and economic diversification.

In the context of developing countries, however, economic growth, on the one hand, and technology and innovation capacity on the other has a mutually reinforcing relationship (Ocampo and Vos, 2009). Technology and innovation capacity play an important role in expanding economic growth of the kind that results from changes in the structure of production. Economic growth often enables technological learning and sophistication, and technological capabilities are critical for ensuring that growth is of a productive nature and can be steadily maintained.

Regardless, these mutually supportive linkages do not emerge spontaneously; much still needs to be done in order to harness this critical relationship in developing countries. For instance, an argument that has often been advanced is that the ongoing growth and shift in production patterns in some of the emerging countries, from low-end manufacturing to more knowledge-based domains, has opened up opportunities for other developing countries, particularly LDCs, to engage in low-end manufacturing (World Bank, 2010; Lin, 2011).

As attractive as this might be, it does not occur automatically. Industrialization processes that could lead to a significant proportion of the total population being engaged in value-added production and manufacturing of the kind that implies spillovers to other sectors require investments in building absorptive capacity. This requires a fundamental shift in the underlying conditions of many developing countries, with a particular focus on factors that promote technological learning and innovation capabilities in these countries. These actions should be consistent with their comparative advantages and local demand.

Much of the mainstream literature on growth and decoupling does not deal with technological development in depth, but calls for a critical analysis of the technology implications of such processes.[14] It seems prudent to assume that even if decoupling were to be achieved, technological learning and capabilities-building would not be an automatic result. In the worst case, it could even entrench the lagging countries further in low-level manufacturing and other modes of specialization that are not conducive to upgrading. This further highlights the importance of focusing on technology and innovation as a primary concern.

While much of the thinking about technology transfer has, for obvious reasons, focused on North-South flows and related challenges, a review shows that developing countries have taken a series of initiatives relating to this issue, particularly since the end of the 1990s. The G-77, for instance, has emphasized the relevance of South-

In the context of developing countries, economic growth, on the one hand, and technology and innovation capacity on the other has a mutually reinforcing relationship.

However, these mutually supportive linkages do not emerge spontaneously; much still needs to be done in order to harness this critical relationship.

The central message of the TIR 2012 is that developing countries, particularly emerging countries, are important partners to promote technological capabilities in the South.

South cooperation for knowledge and technology sharing and exchange. Building on this, regional developments, such as Africa's Science and Technology Consolidated Plan of Action adopted in 2003, emphasize the relevance of knowledge accumulation and innovation capacity for economic development. At the recently held fourth BRICS Summit in India in 2012 and at the G-20 meeting of finance ministers, the Indian Government proposed the creation of a dedicated development bank financed by the BRICS governments to deal with certain key aspects of development, including technology.

Despite such initiatives, most of the literature on South-South cooperation focuses predominantly on trade and investment patterns, with very little direct analysis of cooperation on issues of technology and innovation and what implications this could have for technological learning in the developing world. Data on investment (see chapter II of this Report) show that some investment from developing countries focuses on productive sectors, but the data on this topic remain difficult to gather and are insufficient. There is clearly a need for a systematic assessment of the role of developing countries as partners in building technology and innovation capabilities in the South to enable the development of concrete policy recommendations.

Expanding growth and trade among developing countries holds the prospect that South-South exports of capital goods may also result in technology flows and transfer.

This Report argues that the similarity of development experiences of the countries of the South (particularly in promoting innovation capacity) makes them essential complements to existing North-South interactions. Moreover, they could help provide more development-friendly models of engagement internationally. Given the relevance of the innovation experiences of emerging countries for all developing countries, and the contextual appropriateness of their technologies (see chapter IV), South-South collaboration needs to be systematically promoted. The central message of the *TIR 2012* is that developing countries, particularly emerging countries, are important partners to promote technological capabilities in the South and therefore it is a priority to analyze how South-South collaboration for technology and innovation can be promoted in a systematic way to promote inclusive sustainable development across all developing countries.

The Report therefore focuses on analyzing whether ongoing South-South exchange is leading to building technological capabilities. From an analysis of the current patterns of South-South exchange on technology and innovation issues, the Report seeks to identify key issues in ongoing South-South exchange in this area, and to derive best practices for moving forward in fostering South-South collaboration on technology and innovation.

1. The South as a complement to the North for technology and innovation

There are many channels through which technological diffusion and capabilities accumulation can be promoted across countries. Imports of capital goods still remain a primary means through which firms build technological capabilities. Accordingly, expanding growth and trade among developing countries holds the prospect that South-South exports of capital goods may also result in technology flows and transfer. Other means include FDI, customer-supplier-retailer relationships in value chains and global production networks (GPNs), reverse engineering and copying, interacting with foreign clients on design, standards and quality requirements, and collaborating in joint ventures.

However, using imports of capital goods or FDI or many of the other means listed here (such as participation in global production networks) to promote technological learning requires some level of absorptive capacity within systems. But since institutions in many developing countries, particularly LDCs, tend to be weak, these countries are challenged in their quest to use South-South trade to build their technological capabilities and promote activities leading to structural change and diversification of their economies.

Institutional constraints can be formal and informal impinging on innovation and technological learning (Hall et al., 2001; Nelson and Sampat, 2001), such as a inadequate regulatory frameworks (Dosi, 1988; Nelson and Winter, 1982), low emphasis on organizational learning (Leonard-Barton, 1995) and low human skills and know-how (Romijn, 1997; Teece and Pisano, 1994). Other factors that impede the building of technological capabilities include a lack of access to finance, weak educational opportunities, weak entrepreneurial culture, competition and existing patterns of technological specialization.

In order to overcome these limitations proactive policies are needed at various levels. Emerging countries have used a variety of measures to overcome trade and intellectual property barriers in their own economic development, which can provide important lessons for other developing countries. Their successful experiences show not only how technological capabilities could be built, but also what policy measures could potentially be used to promote national development within the multilateral trading regime. The similarity of their developmental experiences is important, deriving from their similar past and path-dependent constraints on promoting sustainable development (see chapter IV).

Sharing experiences and strengthening collaboration in all ways possible remains very important and relevant for developing countries that are still grappling with ways to create harmonious and coherent local innovation and industrial policy environments. Recognizing this, both policy and scholarly analyses have begun to give greater attention to what lessons can be drawn by developing countries in general from the East Asian experiences, and, more recently, from those of the emerging countries in Asia (see, for example, Stiglitz et al., 2012).

A second and perhaps more important advantage of the South for technological learning is that most of the countries have followed similar pathways in building their capabilities: from reverse engineering to incrementally innovating and then to research and development (R&D). Indeed, most innovation analyses of the emerging countries show that the continuum through which these countries, their sectors and firms have progressed in their quest to build technological capabilities has been quite similar in nature. Developing countries also face a number of similar challenges to innovation. Even amongst the developing countries that can be termed as emerging, while there are many industries that are at the technological frontier globally, many other industries or firms face routine constraints on innovation similar to those prevailing in other developing countries, including LDCs. This implies that to varying extents these countries still face some of the basic issues with regard to promoting the technological absorptive capacities of their systems as a whole.

But…countries are challenged in their quest to use South-South trade to build their technological capabilities.

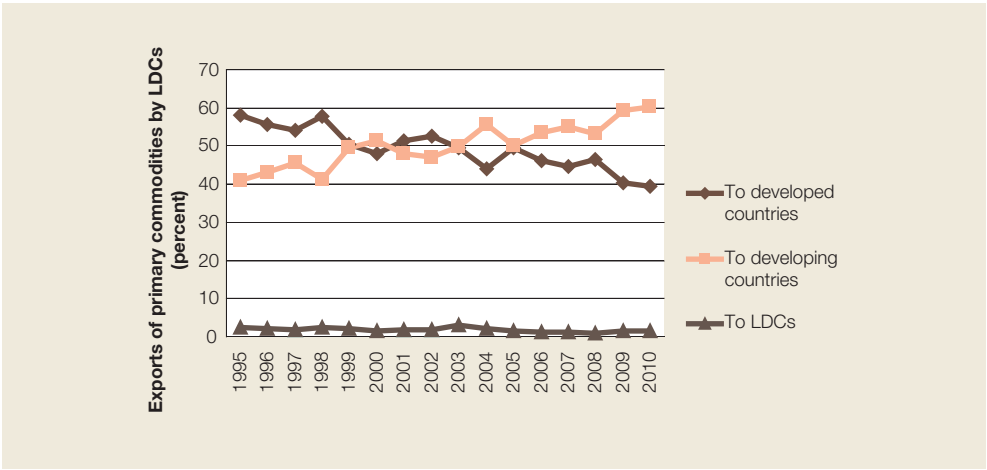
This lends support to the view that the technologies produced by the South may be much more accessible – and contextually appropriate – to other countries and firms of the South, thus highlighting the importance of promoting greater collaboration in this area. However, efforts to identify the factors that contribute to the success of certain countries need to bear in mind that while sharing these policy experiences is important, technological change is highly context-specific in nature, and therefore similar incentives may often not produce the same set of results across countries.

2. Overcoming challenges and divergent interests

Many developing countries still face enormous challenges in achieving poverty reduction and inclusive development.[15] Added to these are more recent and pressing concerns such as those induced by climate change and the need for a shift to a green economy. Furthermore, a number of emerging countries, despite being on a trajectory of industrial catch-up are under pressure to pursue inclusive and sustainable development, particularly with respect to mitigating climate change. Bearing this in mind, the discourse on the role of devel-

A second…perhaps more important advantage of the South for technological learning is that most of the countries have followed similar pathways in building their capabilities.

Figure 1.5: Trends in LDCs' exports of primary commodities, 1995–2010



Source: UNCTADstat.

Technologies produced by the South may be much more accessible – and contextually appropriate – to other countries and firms of the South.

oping countries as technology providers needs to recognize that the South can only complement, *but not replace*, efforts of developed countries to help address technology and innovation issues in a comprehensive way.

As many studies have observed, the divergences among developing countries are perhaps the most starkly evident in the areas of innovation and technological capabilities. Growth trends in LDCs during the period 2000–2010 were driven by an increase in the demand for primary commodities, particularly during the period 1995–2010 (figure 1.5 and annex table A.II.4). Thus, despite rising South-South trade and investment, several developing countries, particularly African LDCs, have become increasingly dependent on commodity exports. This has resulted in a decline in industrial activity, an increase in informal economic activity and persistently high levels of indebtedness.

Discourse on the role of developing countries as technology providers needs to recognize that the South can only complement, but not replace, efforts of developed countries.

Traditionally, LDCs exported their primary commodities mainly to developed countries, but this pattern has shifted significantly towards developing countries since 2003. By 2010, developing countries accounted for about 59 per cent of all primary commodities exported by LDCs, while developed countries accounted for about 39 per cent. The growth of the LDCs has not been accompanied by any significant changes in their production structures (UNCTAD, 2010), and they are increasingly dependent on imports of manufactures from emerging countries. The growth rate of exports of manufactures from Asia in recent years has been extremely high, reaching a record 30 per cent growth in 2010. Of these exports, about 52 per cent went to other developing countries a big share of which included LDCs (WTO, 2011).

These relationships reveal that, in many ways, developing countries compete among each other for similar markets in the South, which may present a problem for smaller developing countries with more vulnerable firms that are seeking to access the same markets to expand. Furthermore, the spike in commodity exports and the continued dependence of LDCs on exports of natural resources is also attributable to the growing demand by developing countries for commodities and natural resources for their own development processes. While this demand is a natural consequence of the growth in their own economies, such South-South trade can have damaging implications for technological upgrading and learning activities in LDCs as discussed here. These issues could be resolved to a large extent through coordinated action among developing countries on issues of technology and innovation.

3. Definitions of key terms

The analysis and conclusions contained in this Report use some terms, such as emerging countries, technological collaboration, technology transfer and innovation capacity. These are defined here.

a. Emerging countries

The process of structural transformation and development in the South is an ongoing dynamic phenomenon that cannot be captured appropriately by any one term. As noted earlier in this chapter, economic growth and technological capabilities have a mutually reinforcing relationship: on the one hand, economic growth translates into expansion of technological capabilities, but at the same time, technological capabilities have a clear impact on ensuring that growth is productive and sustainable. Bearing this in mind, the term "emerging countries", for the purpose of this Report, is used here to denote all developing economies that satisfy at least three of the following criteria:

i. Steady economic growth over the past decade;
ii. An increase in knowledge-intensive exports, both globally and to other developing countries;
iii. Increasing investments in R&D;
iv. A rise in indicators of progress in science and technology, such as scientific publications and patents; and
v. Associated policy and institutional underpinnings that tend to be oriented towards long-term economic development.

In assessing the growing alliances within and between countries of the South, that have already crossed a threshold of industrial development (such as the East Asian economies) and those that are emerging along the same path, this Report uses the term emerging countries to denote countries such as Brazil, China and India, as well as, increasingly, other developing countries in Latin America (such as Mexico) and Asia, as applicable. It is used throughout the analysis in a dynamic sense to also convey the process of structural transformation of these countries and other new ones where such a transformation is currently in motion.

There have been other scholarly works that capture these distinctions in the latecomer countries, classifying them often as latecomers and very latecomers, or dynamic developing countries. Further analyses of the character of this group of countries necessarily enrich the definition to take into account their performance in terms of rapid income and productivity growth and technological development, together with the associated policy and institutional underpinnings that tend to be oriented towards long-term economic development. The term "emerging countries" used in this Report captures all these stages of transformation in technological and overall economic terms.

b. Technological collaboration

This term is used to denote all forms of technological exchange that are geared towards technological learning and capability-building in the recipient countries of the South. These could include, but are not be restricted to, the following kinds of activities: joint research and product development, joint ventures, research collaborations, licensing activities, technology transfer, training and capacity-building between public-public and public-private enterprises, joint patenting, skills development and mobility of labour. The term covers more than scientific and technical collaboration; it includes, in addition, activities that address the capacity to access, use and adapt existing knowledge in firm level activities.

c. Technology transfer

Technology transfer, as defined in this Report, is more than just scientific or technical collaboration. This term is used to include all forms of technological exchange that lead to building the technological capacities of the user/recipient. It includes tacit know-how as an important component, in addition to machinery, equipment and blueprints.

d. Innovation capacity

As opposed to frontier innovation, firms and enterprises in developing countries often build upon existing knowledge to innovate products and processes, which, although not new to the world, are entirely new to them. These activities are incremental in nature, and with time and incentives created by the innovation system at large, result in capability-building. Given that innovation capacity is fundamental to development, the Report defines innovation as all changes to products, processes and organizational forms that are new to the firm or the local context (Schumpeter, 1962; Rosenberg, 1982).

D. ORGANIZATION OF THE REPORT

Following this introduction, chapter II seeks to explore the emerging landscape on technology and innovation exchange in the South in order to ascertain if and to what extent the data and trends on South-South technological collaboration can be interpreted across a range of variables, to draw a complete picture. The main focus of this chapter is to assess experiences of technology collaboration and transfer in order to determine whether existing and emerging trends point towards the emergence of South-South collaboration on technology and innovation issues. It also critically analyses how and to what extent such technological collaboration can be expected to build technological capabilities across developing countries.

Chapter III further builds on this broader picture to present some ongoing cases of South-South collaboration on technology and innovation in detail. The chapter shows that such collaboration takes the form of important government initiatives and firm-level collaboration in some sectors. In particular, firm-level collaborations in renewable energy technologies (RETs), pharmaceuticals and health and agricultural technologies offer interesting case studies.

Chapter IV deals with the following pressing question: how can the South be a better partner in efforts to promote innovation and technological learning in the developing countries? Collaboration on technology and innovation is perhaps one of the most critical areas of South-South solidarity, offering real promise for sustainable development across the South. The chapter calls for an international framework to harness the potential of ongoing South-South technological exchanges for building technological capabilities in developing countries and for bridging the ever-widening global technological divide. It then articulates a set of principles that could form the basis of such an international framework. These principles are based on the need to resolve some major issues that currently stand out in the global and developing-country context of technology and innovation exchange.

As a complement to the key ideas presented in this Report, chapter IV also proposes some policy elements for action. These comprise a set of policy incentives for all developing countries that should work in tandem to create an overarching framework for South-South collaboration in technology and innovation. If such collaboration is to become a reality, institutions need to adopt a long-term perspective which is not confined to the technology supplier alone; they need to consider the technology recipient as well, because capability-building necessarily requires coherent efforts and support from the international community. In order to promote such a holistic approach, the chapter proposes policies at different levels (international, regional and national) of support to developing countries.

Chapter V of the Report is a brief epilogue, which seeks to draw conclusions from the analyses contained in the preceding chapter as part of the broader debate on South-South cooperation.

NOTES

1. Referred to as the Asian miracle, the first-tier newly industrializing economies (NIEs) that followed Japan's industrialization comprised Hong Kong, the Republic of Korea, Taiwan Province of China and Singapore, and the second-tier comprised Indonesia, Malaysia and Thailand.
2. See box 3.2 in chapter III. Some other studies such as UN-ECOSOC (2008) quote higher figures. This reflects the considerable variation in the quality and availability of data from the four major contributors from the South – the Bolivarian Republic of Venezuela, China, India and the Republic of Korea. Furthermore, this figure may underestimate total development assistance by the South, since several smaller bilateral and multilateral contributions were not included in the study due the paucity of data and differences in definitions of what constitutes development cooperation.
3. The Russian Federation is not a member of the G-77.
4. The first summit was held in the Russian Federation.
5. de Melo and Panagariya (1993) critically analyse the impact of regional PTAs in the 1960s and 1970s on developing-country trade trends.
6. See table 2.2 in chapter II, which shows that in 1995, 35 per cent of imports of developing countries were sourced from other developing countries, and by 2010 this figure had exceeded 53 per cent.
7. This could potentially be explained by the strong trade linkages between several countries in the region with North America.
8. See annex table A.II.12.
9. East Asia accounts for about 73 per cent of the total FDI from Asia (see figures 2.11–2.13 presented in chapter II of this Report and annex table A.II.15).
10. See for example, the case of technology transfer from foreign firms through backward linkages to the Indian truck industry (Lall, 1980). Also see the case of catch-up in the South-Korean economy (Chapter IV).
11. The term "enclave" economies is used in the literature to denote increasing dependence of countries on resource enclaves that are mostly oil and gas-based, but it can also extend to mining and some forms of tourism. See also the analysis on FDI in chapter II of this Report.
12. For a discussion on how South-South technological collaboration can help address climate change and public health, see Correa (2011) and UNCTAD (2010a) respectively.
13. Several aspects of the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) have given rise to concerns regarding whether, and if so, how, developing countries and LDCs could design local regimes that promote technological learning (see, for example, Correa, 2011; Roffe et al., 2005; Gallanger, 2005).
14. Much has been written on institutional and evolutionary economics (Nelson, 1982; Freeman, 1982; Teece and Pisano, 1994) and on economic catch-up (Amsden, 1989; Amsden and Chu, 2003; Stiglitz et al., 2012) identifying the importance of technological change and innovation capacity in the catch-up processes. The mainstream literature on growth however, does not contain detailed treatment of the implications of technological capabilities for the process of convergence.
15. According to World Bank estimates, in 2010 the poverty head count ratio for people living on less than $1.25 a day was 14 per cent for China, 8 per cent for Brazil and close to 42 per cent for India.

2 THE EMERGING LANDSCAPE OF TECHNOLOGY AND INNOVATION EXCHANGE IN THE SOUTH

CHAPTER II

THE EMERGING LANDSCAPE OF TECHNOLOGY AND INNOVATION EXCHANGE IN THE SOUTH

A. INTRODUCTION

Technological change and economic growth have a mutually reinforcing relationship in developing countries. Sustainable economic growth that is built on productivity increases in these countries does not rely on frontier innovations, as in industrialized countries, but rather, on the possibility to learn and build upon already existing technologies. This requires investment not only in the manufacturing sector, but also across a range of activities that support overall industrial development, including marketing, managerial and financial services, as well as in infrastructure and learning activities. This in turn increases absorptive capacity and the ability to adapt and apply existing technologies by means of local innovations, and thus leads to a gradual increase in productivity in all sectors.

Such growth is intrinsically tied to how production structures evolve and what kinds of factors, policies and institutions enable the diffusion of technological knowledge to domestic sectors and firms (Ocampo, 2004). Empirical work in this area reveals the relative weight of some factors in dictating the process of technological change and productivity growth. Particularly, opportunities can arise as part of various international transactions, including technology spillovers from FDI (Benhabib and Spiegel, 1994; Pavitt and Soete, 1982), participation in GPNs or simply accessing technology through the import of capital goods.

A first factor, which is a significant contributor to technological learning and capacity-building, is the import of capital goods. Imports of capital goods have long been recognized in the literature as a contributor to technological learning and capacity building. Participation in GPNs and FDI could promote learning and capabilities building through technological spillovers to local firms either directly through licensing and technology transfer, or more indirectly through tacit know-how accumulation in local personnel. The impact of these channels on capabilities building depends on the presence of some level of absorptive capacity within countries.

A significant contributor to technological learning and capacity-building is the import of capital goods...

Country and context-specific factors such as education (particularly vocational and tertiary education), availability of capital (public and private), knowledge infrastructure (such as testing and design laboratories, public centres of excellence and universities), quality standards and quality control facilities are instrumental in promoting the absorptive capacity of firms to avail of technological opportunities. New knowledge related to processes acquired by these means enables increases in output, while knowledge related to new products helps local firms create newer markets or expand already existing markets. This leads to economies of scale and provides further scope for growth.

...participation in GPNs and FDI are other factors.

In the specific context of South-South, as chapter I shows, the growing economic and commercial interests of some developing countries have been fuelling market expansion and some level of technological collaboration with other countries of the South. Within these transactions, imports

There has been a marked increase in trade in capital goods among developing countries since the mid-1990s.

of capital goods and growing participation in GPNs may help local firms accumulate knowledge, not only of the kind related to technical aspects of production, but also of managerial, business and quality-related aspects. FDI and licensing can also have important implications for technology acquisition and learning in some contexts. However, to what extent this holds, and whether economic growth in the South and the resulting rise in South-South trade and investment do indeed lead to a surge in technological learning and innovation capacity remain important questions.

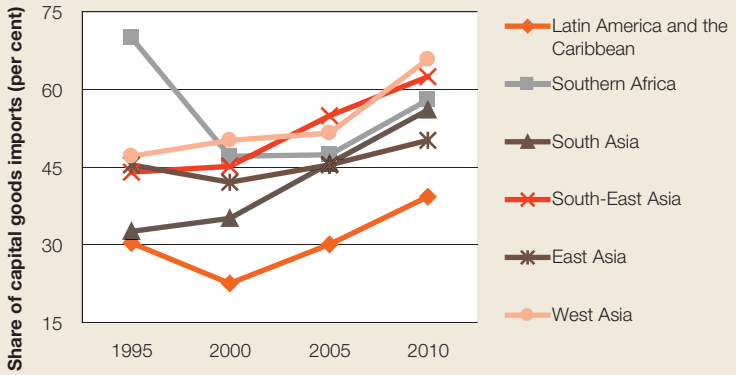
This chapter seeks to examine these channels of interaction to analyze whether existing and emerging trends point towards a systematic emergence of South-South collaboration on technology and innovation issues. Section B presents available data on the trends in imports of capital goods, FDI and participation in GPNs.[1] Section C analyses on the basis of existing data and trends as to whether ongoing South-South exchange is having impact on technological change and innovation capacity in recipient countries, and, if so, under what circumstances. This section also examines the kinds of technologies being shared and the types of alliances and partnerships that have been forged. In addition, outstanding issues relating to current patterns of technology and innovation in the South-South context are highlighted. Section D of the chapter concludes.

B. INCREASE IN IMPORTS OF CAPITAL GOODS FROM THE SOUTH

There has been a marked increase in trade in capital goods among developing countries since the mid-1990s. This is particu-

Overall trends show a clear shift away from developed countries as sources of such goods towards developing countries during the period 2005–2010.

Figure 2.1: Growing regional share of capital goods imports (as part of total imports) from developing countries (Per cent)



Source: *UNCTADstat.*

Note: *Southern Africa comprises: Botswana, Lesotho, Namibia, South Africa, Swaziland. South Asia comprises: Afghanistan, Bangladesh, Bhutan, India, Iran (Islamic Republic of), Maldives, Nepal, Pakistan, Sri Lanka. East Asia comprises: China, Democratic People's Republic of Korea, Hong Kong (SAR of China), Macao (SAR of China), Mongolia, Republic of Korea, Taiwan Province of China. South-East Asia comprises: Brunei Darussalam, Cambodia, Indonesia, Malaysia, Myanmar, Singapore, Thailand, Lao People's Dem. Republic, Philippines, Timor-Leste, Vietnam. West Asia comprises: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, United Arab Emirates, Turkey and Yemen. Latin America and the Caribbean comprises: Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bolivia, Brazil, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guyana, Haiti, Honduras, Jamaica, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela.*

Table 2.1: Regional share of imports of capital goods (as part of total imports) from developing and developed countries, 1995 and 2010 (Per cent)

		Importing region					
		Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
		1995			2010		
Partner	Developing countries	35.36	62.21	2.43	53.99	43.78	2.23
	Latin America and the Caribbean	30.42	68.80	0.79	39.27	60.02	0.71
	Southern Africa	..	..	..	57.90	41.46	0.64
	South Asia	32.45	65.00	2.56	56.06	42.36	1.57
	South-East Asia	44.13	55.43	0.44	62.57	36.67	0.76
	East Asia	45.52	53.73	0.75	50.21	47.03	2.76

Source: UNCTADstat.

Note: For the country composition of each of these subgroups, see note to Figure 2.1.

Table 2.2: Share of select developing countries' imports (as part of total imports of capital goods) from developing and developed countries, 1995 and 2010 (Per cent)

		Importing region					
		Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
		1995			2010		
Partner	Brazil	44.25	54.52	1.24	60.24	37.91	1.86
	India	35.45	62.28	2.27	59.16	39.44	1.4
	China	44.73	54.61	0.66	42.87	53.92	3.22
	South Africa	..	..	..	59.77	39.54	0.68

Source: UNCTADstat.

larly significant because overall trends show a clear shift away from developed countries as sources of such goods for developing countries during the period 2005–2010, especially after the economic slowdown in 2008. As part of rising South-South trade, the share of developing countries' imports from other developing countries has increased steadily, from 35 per cent in 1995 to 54 per cent in 2010 (tables 2.1 and 2.2 and figure 2.1), thereby rendering developing countries as the major source of capital goods for other developing countries.

Many factors have contributed to the growth of imports of capital goods by developing countries between 1995 and 2010. One important factor has been trade liberalization undertaken by many of these countries, including through the reduction of tariffs and the removal of quantitative restrictions in the context of the Uruguay Round agreements of the General Agreement on Tariffs and Trade. The absence of major economic shocks during the period 1995–2000, enabled the further expansion of trade. However, by the end of the 1990s, the financial crisis that hit the East Asian economies and its contagion effects led to markedly lower growth rates in the affected countries. This contributed to the growing importance of trade between developing countries. More recently, the global financial and economic crisis has had a similar effect.

This implies a growing capacity in the South to produce such goods…

An important aspect of South-South trade in capital goods is that it varies considerably, both across groups of countries and between individual countries. As observed with overall imports from each region, there are also other intraregional and intra-country variations. An analysis of interregional variations shows that the South-East Asian countries and South Asian countries (particularly China and India) have depended more on developing countries than on the developed countries to meet their import requirements for capital goods after 2000 (figure 2.1 and table 2.2).[2] Amongst the other regions, Latin America and the Caribbean have also witnessed a similar increase whereas this has not been the case in Southern Africa. At 60 per cent each, Brazil, India and South Africa have a large share of capital goods from their Southern partners (see table 2.2).

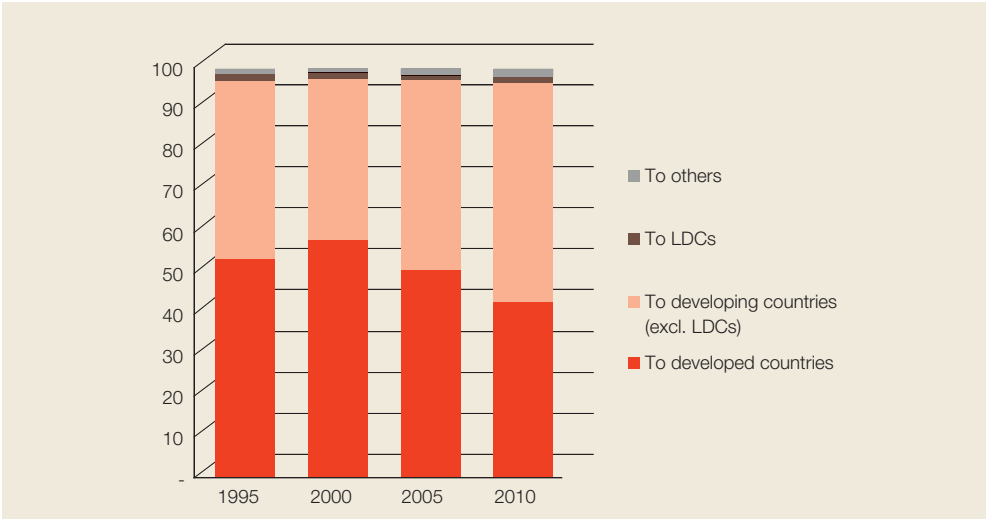
…and a growing trend in other developing countries to import these as part of their expanding efforts to promote productive capacity.

These trends are supported, and are very similar to, overall trade trends (see chapter 1, figure 1.2), which indicate that South-South trade has progressively increased in importance in comparison with South-North trade. South-North trade declined from 57 per cent of total global trade in 1995 to 42 per cent in 2010, whereas South-South trade rose from 42 per cent to 56 per cent over the same period (table 1.1 in chapter 1). The regional variations in total South-South trade and South-South trade in capital goods also follow a similar pattern with South Asia and South-East Asia accounting for the highest share of intra-South trade and capital goods imports.[3]

This implies a growing capacity in the South to produce such goods, at least in some countries, but also that there is a growing trend in other developing countries to import these as part of their expanding efforts to promote productive capacity. As noted earlier, such imports are important for building productive capacity, since they can result in the transfer of technology to the extent that those are studied for design characteristics and reverse engineering. They can also directly improve productivity when they are employed in production processes. This is captured in part by the marked increase of manufacturing exports from developing countries (excluding LDCs) to other countries (figure 2.2).

As figure 2.2 shows, the growing manufacturing capabilities in a number of developing countries, particularly Brazil, India, China and South Africa, has enabled them to increase their exports of capital

Figure 2.2: Trends in export distribution manufacturing of developing countries, 1995–2010 (Per cent)



Source: UNCTADstat.

goods. It has also enabled them to participate in GPNs in both low-cost manufacturing and high-technology value-added production. Moreover, globalization, as well as newer technologies and the move towards the knowledge economy, especially information and communication technologies (ICTs), have provided opportunities for these countries to use their existing skilled workforce to accumulate further knowledge and promote technological learning. While India sought to promote local enterprises through reverse engineering and production, China, for instance, opted for a dual approach – promoting local enterprises but also attracting investments by global TNCs. In some, though not all, of the developing countries, particularly the emerging countries, TNC activities through subsidiaries have contributed to an overall effort to build technological capabilities (OECD, 2011). Regardless of the means and policy incentives, these countries have been able to use their existing supplies of engineering and entrepreneurial skills, aided by investments in infrastructure, to build their technological capabilities and improve the quality of goods produced.

The relocation of production facilities to some developing countries has taken on a new meaning in the context of growing competitive technological capabilities of these countries in many sectors. Such relocation involves not only production activities, but also aspects of R&D, especially in India and China (UNCTAD, 2005). A new, gradual reconfiguration of manufacturing and innovation activities at the global level is taking place (Chesbrough, 2003; 2006) in which several developing countries are beginning to play a critical role. In 2007, the Chinese economy accounted for 36 per cent of all manufacturing value-added goods produced worldwide (UNCTAD, 2007). Moreover, since 1999 there has been a sharp increase in R&D expenditure in China, averaging approximately 24 per cent per annum. Indeed, China's R&D-to-GDP ratio has more than doubled in a decade to reach 1.70 per cent in 2009. Meanwhile, India follows the United States in being the second most favoured location in the world for offshoring of R&D (Economist Intelligence Unit, 2007).

As a result of all these factors, developing countries have become larger exporters of capital goods, including manufactured goods, than developed countries for other countries within the South over the past decade (table 2.1 and 2.2 and figure 2.2), a trend that is expected to continue well into the future.

The growing manufacturing capabilities in a number of developing countries…

1. Growing technological intensity of imports and participation in production networks

Within these broad trends, there has been a consistent increase in imports of high-technology-intensive goods in the South. A closer look at the growing technological intensity of South-South imports shows that, on average, over 53 per cent of all high-technology products imported by developing countries as a group was sourced from developing countries (tables 2.3 and 2.4 and figures 2.3 and 2.4). Comparing the level of technological intensity (low, medium and high technology-intensive) of developing-country imports, there was a larger share of manufactured imports of high technology intensity than those of medium skill and technology intensity (tables 2.5 and 2.6 and figures 2.5 and 2.6 for similar data on medium-technology-intensive manufactures).

A substantial share of high-technology exports from the South are directed to developing countries. For instance, 60 percent of Brazil's high technology exports, 54 per cent of China's high technology exports and 47 per cent of India's high technology exports were sourced to developing countries as a whole (table 2.4). Developing countries remain the largest importers of high technology products from East Asia (64 per cent of East Asia's total exports). The results for the South Asian sub-region and India are significant and seem to sug-

…has also enabled them to participate in GPNs in both low-cost manufacturing and high-technology value-added production.

gest that they are both integrating more rapidly with the high-skill and technology-intensive industries, a trend that is similar to what was witnessed in South-East Asia in its earlier stages of development.

Within these broad trends, there has been a consistent increase in imports of high-technology-intensive goods in the South.

However, these trends are uneven across regions, and are largely explained by the existence of production networks in South-East Asia, and more recently in South Asia. The gains of these countries in technological sophistication facilitates their ability to absorb products with high skill and technology intensity better than some of the other regions shown in table 2.3, such as Southern Africa. Similar trends can be observed with respect to medium-technology intensive imports (tables 2.5 and table 2.6).

An analysis of the data and trends for high-technology and medium-technology intensive sectors reveals the following patterns of technology intensity in imports:[4]

Table 2.3: Imports of capital goods with high technology intensity sourced from developing countries (as a percentage of total imports), by regional groups, 1995 and 2010

		Importing region					
		Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
		1995			2010		
Partner	Developing countries	24.85	74.07	1.08	53.04	46.23	0.73
	Latin America and the Caribbean	26.62	73.31	0.07	34.14	65.35	0.51
	Southern Africa	..	..	..	58.60	40.74	0.66
	South Asia	52.13	37.76	10.11	47.60	45.06	7.34
	South-East Asia	42.93	56.64	0.43	54.61	44.82	0.56
	East Asia	42.14	57.19	0.67	64.67	33.89	1.44

Source: *UNCTADstat.*

Note: *For the country composition of each of these subgroups, see note to figure 2.1. 'Others' refers to transition economies and Oceania.*

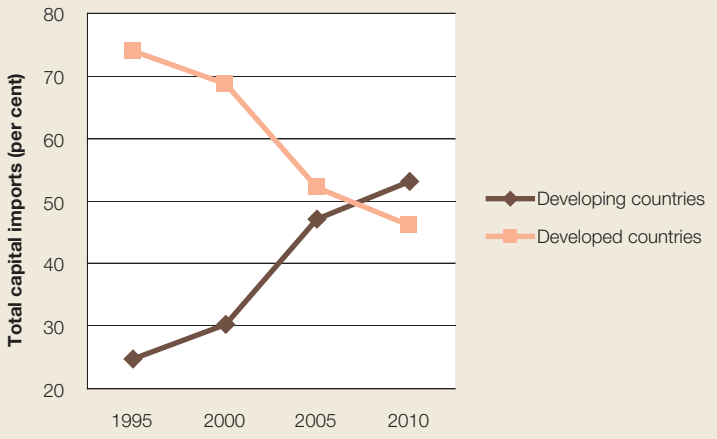
A substantial share of high-technology exports from the South are directed to developing countries themselves.

Table 2.4: Imports of capital goods with high technology intensity sourced from developing countries (as a percentage of total imports), by select developing countries, 1995 and 2010

		Importing region					
		Developing countries	Developed countries	Others	Developing countries	Developed countries	Others
		1995			2010		
Partner	Brazil	45.73	54.2	0.07	59.69	39.89	0.42
	India	52.52	37.13	10.36	47.39	45.41	7.2
	China	47.23	52.37	0.41	54.13	43.74	2.13
	South Africa	..	..	..	61.1	38.18	0.72

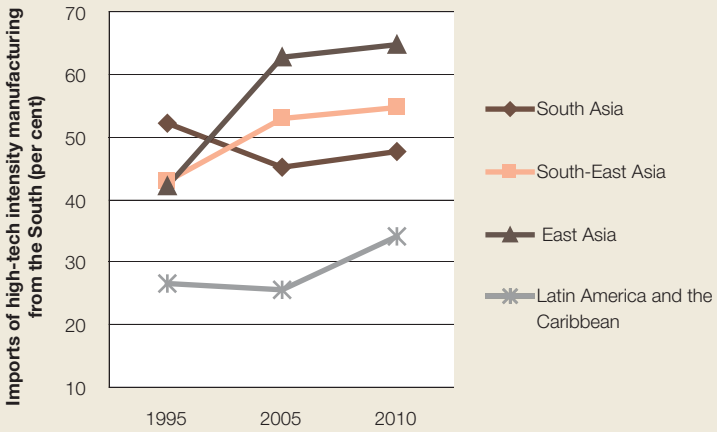
Source: UNCTADstat.

Figure 2.3: Imports of capital goods with high technology intensity by developed and developing countries (as a percentage of total global imports), 1995–2010



Source: UNCTADstat.

Figure 2.4: Imports of capital goods with high technology intensity as a percentage of total imports from developing countries, by selected regions, 1995–2010[a,b]



Source: UNCTADstat.

Note: For the country composition of each of these regions, see note to figure 2.1.

[a] *The data refer to imports of goods of high technology intensity by various regional groups from developing countries as a whole.*

[b] *For corresponding percentages for Southern Africa, see Annex table A.II.8.*

i. South-South imports are the highest in telecommunications and sound recording and reproducing apparatus and equipments.

ii. Office machines and automatic data processing machines are also relatively significant in the imports of developing countries from other countries of the South.

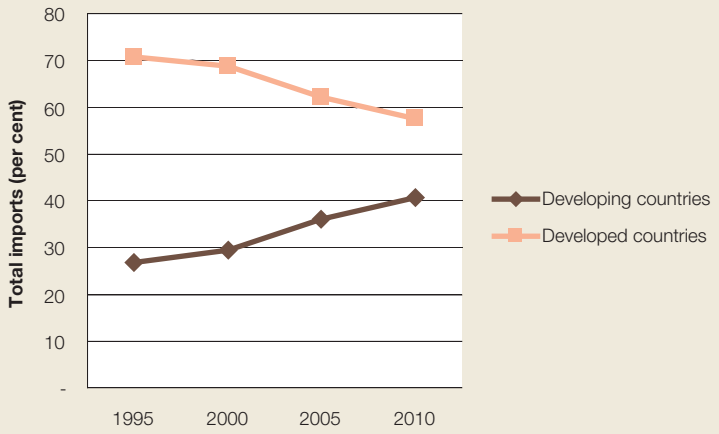
iii. South-South imports of power-generating machinery and equipment have not been very significant, constituting only 29 per cent of the total imports of this product category by developing countries in 2010.

iv. South-South imports of products in some sectors that have public welfare implications is on the rise, such as pharmaceuticals.[5]

While these patterns remain important, the underlying question that is critical is whether these technological imports are of a kind

While these patterns remain important, the underlying question that is critical is…

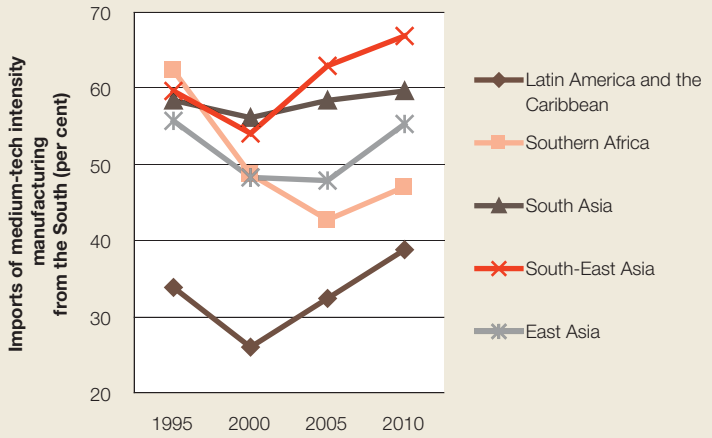
Figure 2.5: Imports of capital goods with medium technology intensity by developed and developing countries (as a percentage of total global imports), 1995–2010



Source: UNCTADstat.

…whether these technological imports are of a kind that promotes technological capabilities in developing countries?

Figure 2.6: Imports of capital goods with medium technology intensity as a percentage of total imports from developing countries, by selected regions, 1995–2010



Source: UNCTADstat.
Note: For the country composition of each of these subgroups, see note to Figure 2.1.

A predominant factor explaining the technological import trends is the growth of production networks driven by some of the more technologically advanced developing countries.

that promotes technological capabilities in developing countries? From the available data on South-South technology exchange (as analyzed here in this chapter), and existing case studies and other evidence (discussed in chapter III), the patterns of such exchange can be explained by a few ongoing developments.

A predominant factor explaining the technological import trends is the growth of production networks driven by some of the more technologically advanced developing countries. In addition, increasing domestic demand in some of the emerging countries – particularly China and India – due to their large populations and the increasing purchasing power of the growing middle class, is a factor explaining the surge in imports of technological products from other countries in the South into these economies. These imports, as data trends show, serve as inputs for the expanding economic activities and consumption patterns in these countries. Some emerging countries are able to manufacture several high-technology products at competitive (and often lower) prices, which are leading to a shift in imports of the South from developed countries to developing countries.

On a general level, a country can import capital goods so long as it can pay for them. However, what remains important for productivity growth is how these imports are channeled effectively into generating future income. This brings us back to the issue of how firms and sectors are able to adapt and use technologies embodied in these imports to generate productivity growth. So long as this is possible and evident, it would lead to the conclusion that such imports of capital goods are contributing to building technological capabilities in developing countries. On this aspect, two trends stand out. First, the trends show that countries with an already existing minimum level of technological capabilities are engaging in extensive trade in capital goods with other countries of the South. This points to the importance of some level of technological capacity to participate in capital goods trade, underscoring the fact that while any country could import capital goods, those that consistently participate in such capital goods trade are the countries where these imports feed into enhancing production capacities.[6] This is underscored by the second trend, which shows a significant overlap between countries that import capital goods and those that export goods with technological content. In order to illustrate these trends further, figures 2.7 and 2.8 present data on imports of high-skill and technology-intensive manufactures, and machinery and transport equipment.

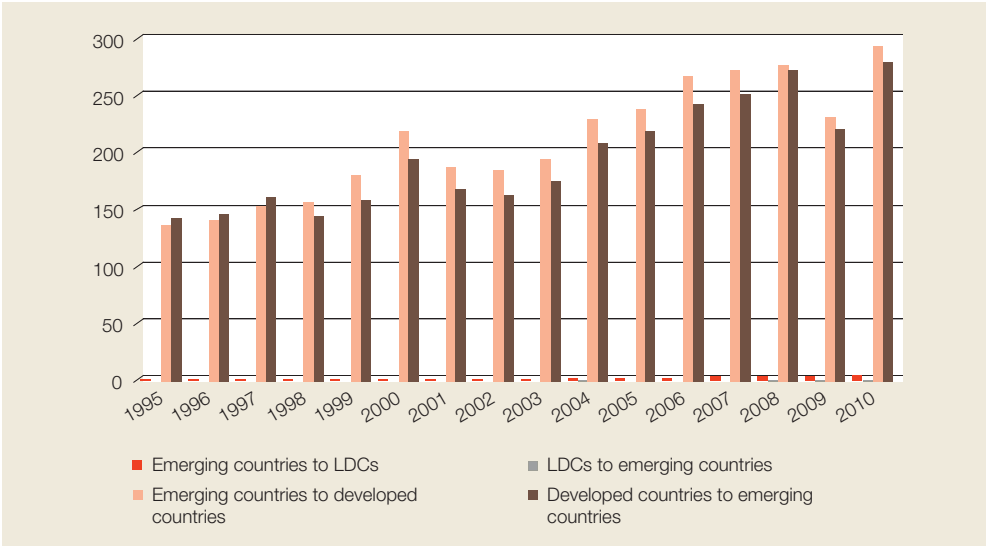
This is not to completely exclude the presence and importance of technological transactions in other countries of the South. While countries of the South mutually import technology-intensive goods from each other, many are limited by the smaller size of their markets, lower ability to pay and the lower technological intensity of their overall economic activity.

Regarding imports of machinery and transport equipment, the gap is also widening and conforms to the other trends presented in this section. Developing countries as a group increased their imports of machinery and transport equipment as a share of global imports of this category from 27 per cent in 1995 to 53 per cent in 2010. However, countries with lower technological capacities, such as a large number of the LDCs, increased the share of their imports of these categories from only 0.04 per cent in 1995 to 0.08 per cent in 2010.[7] Among the LDCs, the oil-exporting LDCs accounted for a large amount of the increase in these imports, showing that such imports are sectorally biased towards the commodity sectors. This is captured in figure 2.10 shows a large gap in the imports of machinery and transport equipment between LDCs and other developing countries.

A country can import capital goods so long as it can pay for them...

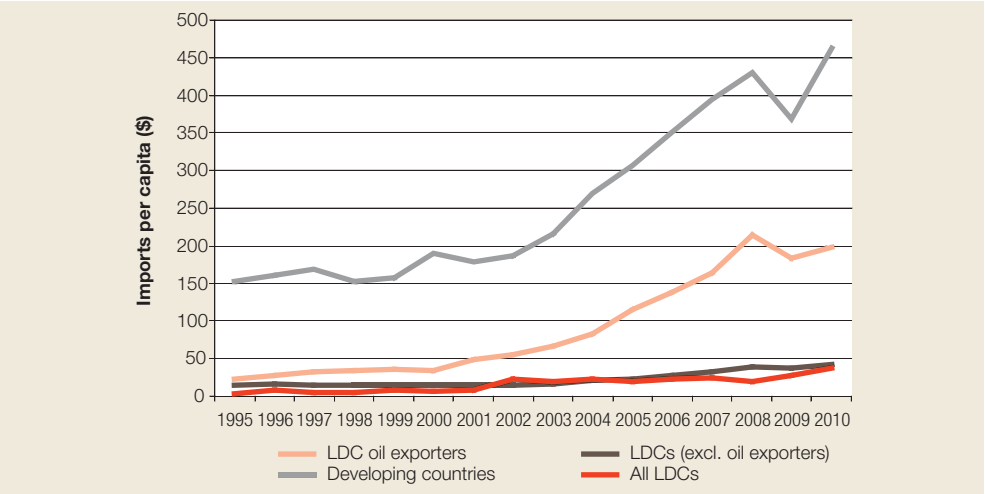
...what remains important for productivity growth is how these imports are channeled effectively into generating future income.

Figure 2.7: Exports of high-technology manufactures by countries, 1995–2010 ($ million)



Source: UNCTADstat.

Figure 2.8: Imports per capita of machinery and transport equipment by developing countries and LDCs, 1995–2010



Source: UNCTADstat.

Note: LDC oil exporters in the figure are: Angola, Chad, Equatorial Guinea, Sudan and Yemen.

Currently, countries that consistently participate in such capital goods trade are the countries where these imports feed into enhancing production capacities.

2. South-South FDI and technology flows

The role of FDI in promoting technology transfer – through licensing, technological spillovers and skills development – and its impact on rising productive capacity in recipient countries is being increasingly explored. Literature on this shows that TNCs engage in FDI when it offers them advantages, either in terms of capital or technology, or both (see for example, Lipsey and Sjoholm, 2005; Dunning, 1993; UNCTAD, 2006a and 2007). In addition to providing capital and setting up particular kinds of production facilities in the host country, there are several instances where skills, especially tacit know-how, have been transferred from international firms to local actors through routine production activities of the firms (see also chapter IV, and UNCTAD 2006a, 2011a and 2011b).

Many are limited by the smaller size of their markets, lower ability to pay and the lower technological intensity of their overall economic activity.

As mentioned earlier in this chapter, FDI can potentially lead to learning and the building of capabilities through technology spillovers to local firms. This can happen either directly through licensing and joint ventures that entail technology transfer, or indirectly through tacit know-how accumulation by local personnel. Licensing offers access to technology by enabling local firms or subsidiaries to purchase production and distribution rights (protected by IPRs) and the know-how required to enable the exercise of production and distribution rights (Maskus, 2004). Where FDI is part of a joint venture, the TNCs usually provide knowledge-based assets, whereas the local firms leverage their locational advantages such as distribution networks, low-cost labour and government support (see chapter III for case studies). FDI can also result in indirect technology spillovers to other firms in the economy through tacit know-how of products and processes acquired by local employees. Over time, through the movement of those employees to other firms, such tacit know-how is transferred to those firms.

a. Outward FDI from developing countries

FDI by developing countries has been rising in recent years, increasing the possibilities for it to be leveraged for technological learning in various other developing countries. The importance of developing countries as sources of FDI has increased quite significantly and steadily over the past four decades (table 2.7 and figures 2.9 and 2.10), although it declined somewhat in 2008, following the eruption of the financial and economic crisis. The share of developing countries in total outward FDI rose from 15 per cent in 2005 to 27 per cent in 2010, but preliminary estimates for 2011 indicate that it may have declined to 21.4 per cent.

Table 2.7: Outward FDI from developing countries, 1970–2010 ($ million)

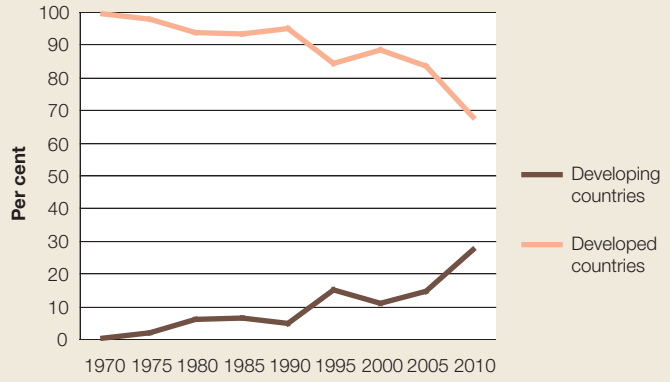
	$ millions at current prices	As a percentage of total global outflows
1970	50.97	0.36
1980	3 192.39	6.19
1985	3 962.13	6.39
1990	11 914.02	4.93
1995	55 723.59	15.34
2000	135 116.42	11.02
2005	132 507.00	14.91
2010	400 144.12	27.57

Source: UNCTADstat.

Analysing FDI outflows from the various developing regions to the rest of the world since the 1970s shows a declining trend in FDI from Africa, from 37 per cent in 1970 to 1.8 per cent in 2010,[8] and from Latin America from 61 per cent in 1970 to 30 per cent in 2010.[9] FDI from Asia, on the other hand, rose from 2 per cent to 68 per cent during the same period (figure 2.10). East Asia accounts for most of the outward FDI from Asia (table 2.8 and figure 2.11). There are significant regional variations in outward FDI, which have an impact on the growing share in gross fixed capital formation in these countries.

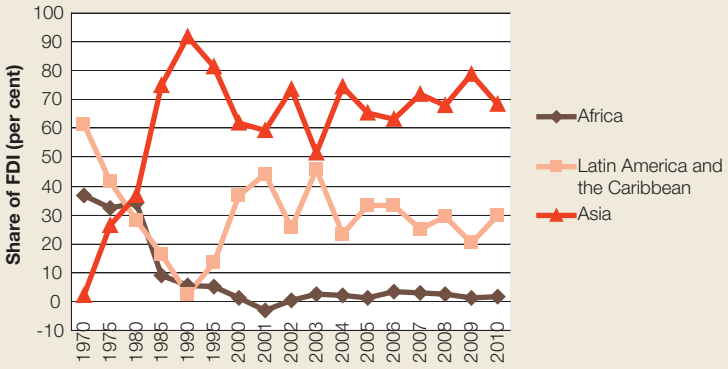
FDI by developing countries has been rising in recent years, increasing the possibilities for it to be leveraged for technological learning.

Figure 2.9: Share of FDI outflows by developing and developed countries in total global FDI outflows, 1970–2010 (Per cent)



Source: UNCTADstat.

Figure 2.10: Shares of FDI outflows from different developing country regions to the rest of the world, 1970-2010[a] (Per cent)



Source: UNCTADstat.
Note: For the country composition of each of these subgroups, see note to Figure 2.1.
[a] *The corresponding data is contained in annex table A.II.14.*

There are significant regional variations in outward FDI in the South.

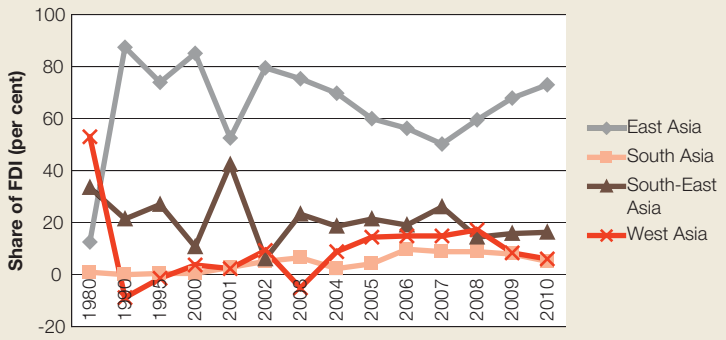
Over the past two decades, the sectoral composition of outward FDI from developing countries has changed significantly.

Table 2.8: Share of FDI outflows by region in total FDI outflows from the South to the rest of the world, 1980–2010 (Per cent)

	Year						
	1980	1985	1990	1995	2000	2005	2010
Africa	34.35	8.99	5.53	5.34	1.14	1.37	1.76
Latin America and the Caribbean	28.15	16.22	2.53	13.49	36.92	33.31	29.97
Asia	36.93	74.77	91.85	81.2	61.94	65.22	68.23
East Asia	4.7	57.04	80.36	60.22	52.72	39.18	49.68
South Asia	0.34	0.71	0.08	0.23	0.41	2.66	3.4
South-East Asia	12.33	13.61	19.54	21.83	6.64	13.99	11.04
West Asia	19.55	3.4	-8.13	-1.09	2.17	9.4	4.11

Source: UNCTADstat.

Figure 2.11: Total Asian FDI outflows to the rest of the world, 1980- 2010



Source: UNCTADstat.
Note: For the country composition of each of these subgroups, see note to Figure 2.1.

During the period 2008–2010, services accounted for nearly 70 per cent of such FDI, of which more than 55 per cent went to developing countries.

b. Sectoral composition of South-South FDI outflows

The impact of FDI on technological learning is generally analysed by assessing the sectoral composition of FDI outflows, where FDI in productive sectors signals a greater probability of learning and spillovers in the host countries. Over the past two decades, the sectoral composition of outward FDI from developing countries has changed significantly. Estimates indicate that in the early 1990s almost three fourths of developing-country investments abroad went to the manufacturing sector, with the primary and secondary manufacturing sectors accounting for 14 per cent and 13 per cent of such FDI respectively. Within the manufacturing sector, rubber and plastics and wood products, two sectors that are based on raw materials sourced mainly from the investing countries, were the most prominent industries (UNCTAD, 2009).

Two decades later, there have been significant changes in the sectoral distribution of outward FDI from the South to other countries of the South (table 2.9 and figure 2.12). During the period 2008–2010, services accounted for nearly 70 per cent of such FDI, of which more than 55 per cent went to developing countries. This was a reflection of the growing advances in services in information technology (IT) and related

Table 2.9: Sectoral composition of FDI outflows from developing countries to the rest of the world, 2008-2010 (Per cent)

Product category	Share of developing countries in total global FDI	Distribution of FDI from developing countries	
		To developing countries	To rest of the world
Primary sector	**13.00**	**5.26**	**7.74**
Agriculture, hunting, forestry and fishing	0.57	0.53	0.04
Mining, quarrying and petroleum	12.41	3.65	8.76
Manufacturing	**12.12**	**11.37**	**0.75**
Food, beverages and tobacco	1.47	..	..
Textiles, clothing and leather	0.16	..	..
Wood and wood products	0.08	..	..
Publishing, printing and reproduction of recorded media	0.00	..	..
Coke, petroleum products and nuclear fuel	0.19	..	..
Chemicals and chemical products	0.53	..	..
Rubber and plastic products	0.13	..	..
Non-metallic mineral products	0.38	..	..
Metals and metal products	1.02	..	..
Machinery and equipment	0.25	..	..
Electrical and electronic equipment	0.88	..	..
Motor vehicles and other transport equipment	0.92	..	..
Services	**69.69**	**54.46**	**15.24**
Electricity, gas and water	0.88	0.88	0.00
Construction	1.16	..	..
Trade	7.72	5.31	2.41
Hotels and restaurants	0.29	..	..
Transport, storage and communications	3.90	2.88	1.02
Finance	15.93	12.15	3.77
Business activities	38.13	..	..
Community, social and personal service activities	0.23	0.08	0.16

Source: UNCTADstat.

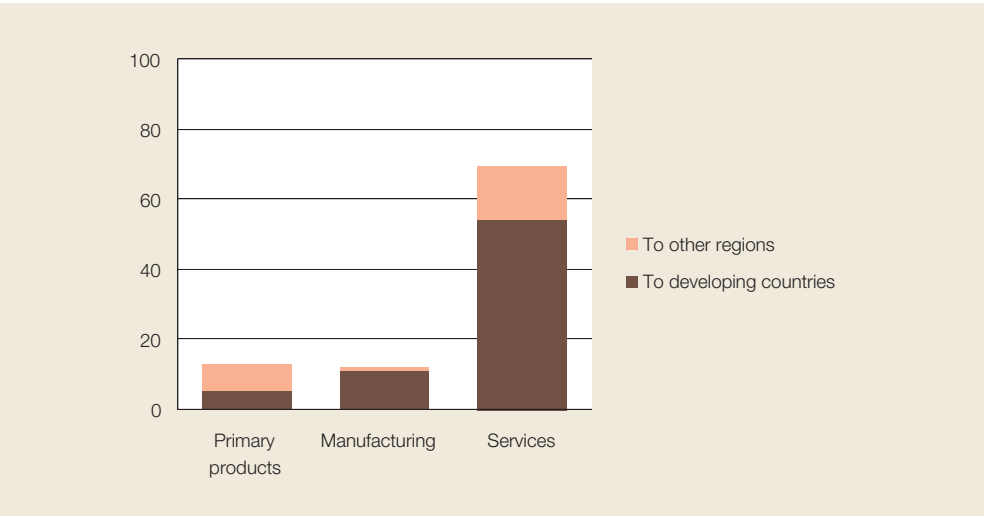
areas by countries like India. In addition, the emergence of global financial centres in Singapore and Hong Kong (China) has raised the profile of financial services in the investment outflows of developing countries. South-South FDI in services and marketing is also expanding in Africa, for instance, where FDI is beginning to diversify into these sectors (UNCTAD, 2011a).

The following summarizes some salient features of South-South FDI that have implications for technological learning.

i. The manufacturing sector has lost importance in FDI outflows. The machinery and transport subsectors are the largest identifiable categories for FDI, signifying the technological advancement of emerging countries in these areas.

Some salient features of South-South FDI have implications for technological learning.

Figure 2.12: Sectoral composition of FDI outflows by developing countries, 2008-2010



Source: UNCTADstat.

Estimates indicate that FDI in sectors such as services and manufacturing originates mainly from East Asian countries and emerging countries.

ii. East and South-East Asia are the main sources of FDI outflows in manufacturing. They have been increasing their presence in electronics, metal and metal products, automobiles, and chemicals and chemical products. The significance of electronics and automobiles in outward FDI from these subregions is in keeping with their position as production hubs, backed by the presence of strong production networks (figure 2.11 and annex table A.II.14).

iii. Asian FDI in manufacturing in Africa and Latin America and the Caribbean is gradually expanding and several studies note that it has considerable potential (UNCTAD, 2011a; Lin, 2011).

This FDI is largely directed to those developing countries that possess strong production networks or have the capacity to source such investments by virtue of their technological capabilities.

iv. Other than business services and finance, FDI in extractive industries (oil and gas, metal mining, as well as other extractive activities) accounted for a significant proportion of total FDI from the East, South-East and South Asian subregions, with China, India, Malaysia and the Republic of Korea being the major investing countries in these sectors. However, not all this FDI is directed to developing countries (table 2.9 and figure 2.12).

A significant issue of relevance for technological learning through FDI arises from the ongoing sectoral changes in its composition. Estimates indicate that FDI in sectors such as services and manufacturing originates mainly from East Asian countries and emerging countries. Moreover, this FDI is largely directed to those developing countries that possess strong production networks in these sectors or have the capacity to source such investments by virtue of their technological capabilities. This is true of a large share of services FDI directed towards developing countries. The FDI thus helps to cement and further their technological capacity as part of existing production networks. Some other FDI outflows, such as those targeting electronics and automobile industries, are directed towards East and South-East Asia, which have globally competitive production hubs. The FDI outflows targeting mining and natural resources are directed towards resource-rich developing countries (including African countries), although a significant part of this FDI is also directed to other regions of the world (table 2.9). The potential technological implication of the rise of FDI in extractive industries is discussed in box 2.1.

Box 2.1: FDI in extractive industries and technological learning

The share of extractive industries in FDI outflows from the South, East and South Asian subregions has been rising. Chinese firms, in particular, have been energetically acquiring mineral assets abroad, as reflected in the share of extractive industries in total FDI outflows from China, which exceeds 20 per cent. This growth of FDI outflows in extractive industries has been driven by the rising demand for critical energy resources in these fast-growing economies, such as China and India. A primary motive for these investments seems to be the search for energy security at a time when commodity prices are on the rise (UNCTAD, 2010a and 2011a). State-owned firms from both China and India have been spearheading investments in natural resources, including oil and natural gas (and more recently in shale gas). But also new investors, including metal companies and conglomerates, such as CITIC (China)[a] and Reliance Group (India), as well as sovereign wealth funds, such as China Investment Corporation and Temasek Holdings (Singapore), have emerged during the past few years. Furthermore, oil and gas and hotels and tourism have been two significant industries in West Asia's portfolio of greenfield projects abroad.

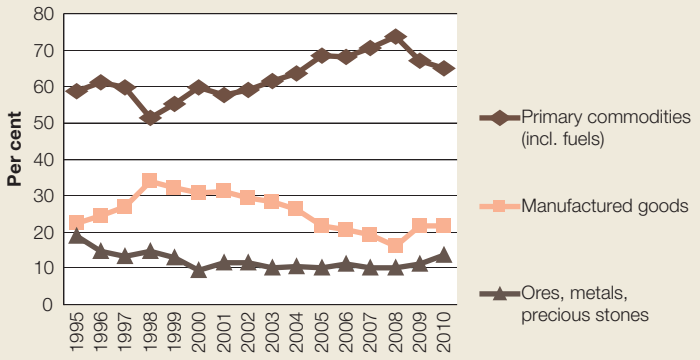
This bias towards extractive industries is captured in box figure 2.1.1, which presents exports of LDCs by product category. The rise in exports of primary commodities and fuels during the period 1995–2010, as shown in the figure, is attributable to the growing demand for these products (see also figure 2.8 in this chapter and figure 4.1 in chapter IV).

In some cases, FDI in activities such as mining could lead to the creation of backward linkages and boost productive capacities in recipient countries. However, the implications for learning or productive capacity-building cannot be automatically derived.

Source: UNCTAD

[a] *The CITIC Group, formerly known as the China International Trust and Investment Corporation, is a state-owned investment company.*

Box figure 2.1.1: Share of primary commodities and manufactures in total LDC exports, 1995–2010



Source: UNCTADstat.

C. IMPLICATIONS OF ONGOING SOUTH-SOUTH EXCHANGE FOR TECHNOLOGY AND INNOVATION CAPACITY

A brief summary of the emerging picture on South-South technology and innovation brings out the following facts. The surge of economic growth in developing countries, particularly emerging countries, has been made possible in large parts by their growing technological capabilities. This is evidenced by the increase in their capital goods exports in recent times. Although capital goods imports by developing countries is a growing trend, and is considered to be an indication of technological learning, the trends presented in section B show that a large share of the capital goods exported and imported is concentrated in a sub-set of developing countries. These are countries that have some level of technological capabilities to integrate into GPNs, and their level of economic growth enables them import capital goods imports into the domestic economy. On the other hand, a large number of developing countries, particularly LDCs, are not major importers or exporters of capital goods.

The FDI thus helps to cement and further their technological capacity as part of existing production networks.

South-South FDI trends show that there has been increase in FDI outflows from the East Asian and the South-East Asian sub-regions, when compared to other regions in the developing world. The data also shows that there are changes in the sectoral distribution of South-South FDI. Notably, a large amount of FDI between developing countries that have some level of technological capabilities is concentrated in services and manufacturing, whereas a large amount of the FDI from developing countries (particularly emerging countries) to other developing countries (particularly LDCs) is largely in the oil and gas sectors.

A large share of the capital goods exported and imported is also concentrated in a sub-set of developing countries.

On the basis of the information available and analyzed in the previous section, how can we best understand ongoing South-South technology transactions and their implications for technological learning, innovation and capacity-building in developing countries? This Section seeks to analyse what these trends imply for developing countries as a whole, as well as for particular sub-groupings.

1. Growing technological divergence in the South

Confirming earlier studies on the topic (see UNCTAD, 2010a; Ocampo and Vos, 2009), there is clearly a diverging trend in the accumulation of technological capabilities among different countries in the South. The data trends presented in the earlier sections of this chapter show that the technological divide among developing countries is not only widening, but there are also elements of South-South trade that entrench LDCs further into exports of primary commodities. Several variables help to assess the extent of this technological divergence: the differences in manufacturing capacities, the variations in patterns of imports of capital goods amongst countries, and capacities for R&D as well as licensing and patenting trends. These are discussed in detail here.

In the case of LDCs, their currently lower levels of technological capabilities limit their ability to benefit from ongoing South-South trade to leverage learning.

a. Capital goods imports of developing countries and LDCs

Compared with many developing countries, LDCs suffer from structural vulnerabilities that remain unmitigated in the process of increased globalization (UNCTAD, 2010a). Several factors, including excessively rapid market-led reforms, gradual technological stagnation within their economies and the growing importance of the global IPR regime and the global knowledge economy, constrain the building of innovation capabilities in most LDCs. The growing demand for primary commodities (see box figure 2.1.1, for example), and thus the increasing dependence of LDC economies on commodity exports, has led to a shift of the labour force in LDCs from agriculture to informal economic activity as opposed to other productive activities, indicating an ongoing process of deindustrialization.[10] It has long been acknowledged that the shift towards manufacturing and knowledge-intensive activities represents a crucial step in technological progress and economic development. The increasing technological divide between LDCs and other countries is evident in the ongoing technological downgrading of activities within key sectors in LDCs, with a decline in the share of manufacturing in total employment (Tregenna, 2009).

Furthermore, as the analysis in this Report shows, some basic level of technological capabilities is a prerequisite for enabling a country to participate in South-South trade in capital goods in a mutually beneficial way. In the case of LDCs, their currently lower levels of technological capabilities limit their ability to benefit from ongoing South-South trade to leverage learning (see next section). Imports of capital goods also seem to be largely concentrated in oil-exporting LDCs, which confirm these observations. Some Asian LDCs are beginning to develop their manufacturing sector and are also creating a services sector, but for most other LDCs, opportunities for technological development remain elusive.

Economic uncertainty caused by regular boom-bust cycles in international commodity prices (UNCTAD, 2010a) as well as local price volatility also have undesirable effects on firm-level activities in LDCs. Such uncertainty acts as a disincentive to local entrepreneurial efforts in both the

private and public sectors, thereby further impeding efforts to build technological capabilities. These factors, in conjunction with other external influences such as the global IPR regime (see chapter IV), affect the ability of LDCs to respond to technological opportunities in the global knowledge economy.

b. R&D trends in emerging countries

The research and development (R&D) trends observed in emerging countries are in stark contrast to those in several other developing countries, pointing to the huge disparity in R&D expenditure across the developing world. Between 2002 and 2009, most of the increase in R&D spending was in the East Asian and South-East Asian regions (table 2.10). In cross-country comparisons, countries such as Brazil and China displayed above average performance for the developing world, whereas India and South Africa have been somewhat lower. Indeed, China had the third largest R&D investments in the world in 2010, after the United States and Japan, with Germany and France lagging behind China (OECD, 2011).

Both conceptually and based on empirical studies, it has been pointed out repeatedly for the South as a whole that rising R&D expenditure does not directly equate with, or explain, the plethora of activities relating to technological development. Rather, R&D expenditure is merely an indication of the broader trends in productive investment, most importantly in infrastructure and human resource development. A useful indicator of innovation and technological capabilities that is regularly used in comparisons between countries is the number of scientific publications and journal articles published. Accordingly, figure 2.13 below presents the trends in such publications between LDCs and a range of developing countries, particularly emerging countries, to capture the levels and growth of human skills in these respective countries between 1986 and 2008. Recent estimates by the OECD (2011) indicate that there has been an increase in investments in tertiary education in all regions outside the developed world. These are not reflected in the figure since there is usually a time lag of one or two decades for increased tertiary education to be reflected in variables such as increased scientific publications (see annex table A.II.17).

Table 2.10: Ratio of R&D expenditure to GDP, by region and select countries, 2002–2009[a] (Per cent)

	R&D Expenditure as percentage of GDP		
	2002	2007	2009
Developed countries	2.22%	2.24%	2.32%
Developing countries (excl. LDCs)	0.83%	0.99%	1.11%
LDCs	0.22%	0.20%	0.20%
Latin America and the Caribbean	0.59%	0.60%	0.66%
Sub-Saharan Africa (excl. South Africa)	0.30%	0.28%	0.29%
Hong Kong, Indonesia, Malaysia, Philippines, Rep. of Korea and Singapore	1.44%	1.76%	1.83%
Brazil	0.98%	1.10%	1.19%
China	1.07%	1.40%	1.70%
India	0.74%	0.76%	..
South Africa	0.73*%	0.92%	0.93*%

Source: *UNESCO Institute for Statistics (UIS) estimations, October 2011.*

Notes: [a] *Data correspond to an year prior to the reference year.*

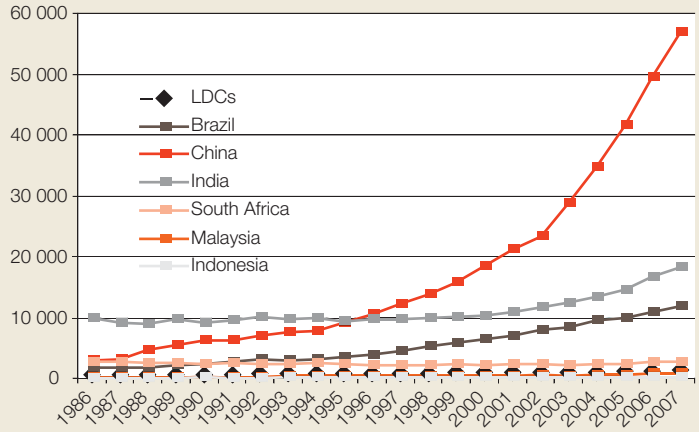
Between 2002 and 2009 most of the increase in R&D spending was in the East Asian and South-East Asian regions.

A large number of developing countries, particularly emerging countries, have begun to obtain patents.

c. Licensing and patenting trends

A large number of developing countries, particularly emerging countries, have begun to obtain patents for a wide variety of conventional and high-technology products and processes in a variety of sectors. For example, there has been a significant rise in patenting of technologies associated with climate change mitigation and adaptation,

Figure 2.13: Number of scientific and technical journal articles in LDCs and selected countries, 1986-2007



Source: UNCTADstat.

Manufacturing activities of the South are gradually integrating into GPNs...

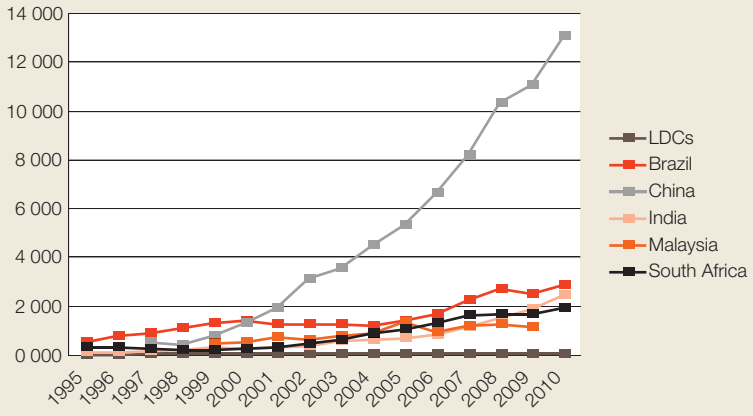
in countries such as Brazil, China and India (UNCTAD, 2011c). Figures 2.14 and 2.15 show the royalties and licence fee payments and receipts in selected countries as indicators of their respective roles in today's knowledge economy. Several East Asian economies lead in these indicators, which give an idea of their share in the knowledge intensity of their ongoing economic activities. In terms of royalty and licence fees receipts (which reflect the overall demand of the IPR assets owned by these countries), China is closely followed by Brazil and Malaysia in order of importance.

2. The leading importers, exporters and innovators in the South

These trends in production and exports of manufactured goods (section B) and related value-added, greater R&D investments and infrastructure expansion and patenting depicted here need to be viewed in parallel with the much less dynamic performances of other developing countries. Manufacturing activities of the South are gradually integrating into GPNs, which are contributing to increasing the technological capabilities of firms in many developing countries.

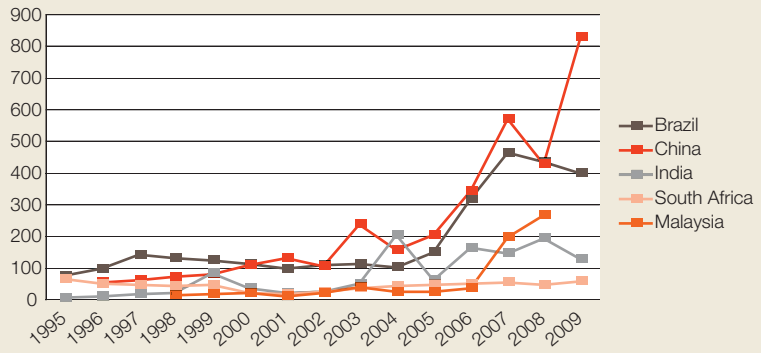
...which are contributing to increasing the technological capabilities of firms in many developing countries.

Figure 2.14: Royalty and licensing payments in LDCs and selected countries, 1996–2010 ($ million)



Source: UNCTAD calculations, based on World Development Indicators (2011).

Figure 2.15: Royalty and licensing receipts in LDCs and selected countries, 1996–2010 ($ million)



Source: UNCTAD calculations, based on World Development Indicators (2011).

The globalization processes of the 1990s have clearly contributed to facilitating this trend. Technological collaboration among developing countries is an aspect of ongoing, progressively expanding manufacturing in the South. However, as this discussion shows, many LDCs and developing countries that do not have some minimum level of technological capabilities have not been able to benefit from GPNs.

a. Manufacturing productivity and technological progress

Variations in manufacturing productivity have traditionally been considered as contributing to growth differentials between countries. With the recognition of technological progress as a factor influencing productivity in the early 1960s, productivity was no longer associated only with the traditional factors of production – labour and capital; it also came to be seen as being directly dependent on technology embedded in the machinery and equipment used in production (Solow, 1956). This role of technology in promoting economic performance of manufacturing firms has also been extensively explored in the literature (box 2.2).[11] Thus it is becoming increasingly important to understand the economic effects of how experiences gained in production can be used to promote innovation capacity related to adapting and improving the technology in use.

b. Participation in GPNs and technological learning

Not only have GPNs played a determining role in bringing economies closer together by stimulating the flows of goods and capi-

Many LDCs and developing countries that do not have some minimum level of technological capabilities have not been able to benefit from GPNs.

Box 2.2: Manufacturing value added and technological learning

The way manufacturing firms build capacity through value-added activities has been widely explored and documented. On the one hand, developed-country firms build their core and strategic capabilities at the international technological frontier, where a certain level of technological capabilities has already been accumulated (Dosi, 1988; Dosi and Marengo, 1993; Nelson and Winter, 1982; Teece, Pisano and Shuen, 1997; Teece et al., 1994). On the other hand, developing-country manufacturing firms have historically lacked the basic technological capabilities which has forced them to build the essential knowledge base that is necessary to survive in the market at all levels – locally, regionally and globally.[a]

Manufacturing exports act as a driver of economic growth by building capabilities that allow greater capacity utilization, export competitiveness, economies of scale, incentives for technological improvements and efficient management in response to competitive pressures from abroad. However, in order to use manufacturing strengths for boosting exports, developing-country firms need to be able to integrate into the global market and meet international standards of production.

Source: UNCTAD.

[a] *Policies in developing countries have often tried to induce this process of learning by limiting foreign imports or TNC presence in the country. Some examples include the Indian and Bangladeshi pharmaceutical sectors.*

Box 2.3: Global production networks in the trade literature

GPNs have been seen both as the products of the process of liberalization of trade and financial flows and as the catalysts for ensuring a greater degree of openness to the global economy. Proponents of this thinking have argued that the liberalization of trade and investment has triggered a change in TNCs, converting them from "tariff-hopping" investors to "global network flagships" (i.e. core firms) that have integrated their dispersed supply, knowledge and customer bases into the GPNs. Fragmentation of production caused by the "network flagships" is assisted by a plethora of specialized networks of suppliers usually spread over a large geographical spectrum (Ernst and Kim, 2002).

Source: UNCTAD.

tal across countries; they have also contributed to knowledge diffusion. In addition, they have provided opportunities for developing local capabilities in countries that are part of the networks. This latter dimension has received relatively little attention in the literature on GPNs, focusing mainly on such networks as a new organizational form for trade integration (box 2.3).

Ongoing experiences of developing-country firms in GPNs shows that successful GPNs tend to...

GPNs have implications for technological learning for the following reasons. To begin with, all suppliers participating in those networks need to meet the standards and expectations of production partners. In order to ensure this, the core firm of the GPN usually transfers technical and managerial knowledge to developing-country participants in the networks. Integration into the GPNs therefore has a reinforcing effect on the ongoing learning processes in the participating developing countries, helping to upgrade the suppliers' technical and managerial skills on a continuous basis. GPNs transfer knowledge across borders through a variety of mechanisms, such as market mechanisms, licensing contracts and/or outright purchase of both technology and plant equipment, among others, which may or may not involve FDI. Secondly, the core firm of the GPN may transfer technologies through the supply chain, and, in doing so, would be exercising control over the manner in which the knowledge is disseminated to and used by the supplier. The control over the supply chain is evident by the manner in which the operations of original equipment manufacturers (or the so-called "tier 1" suppliers) are managed by the core firm of the network.

...contract and rely on local suppliers who have both the capabilities to absorb the knowledge disseminated by the networks and meet the standards of production required.

Secondly, the increasing rate of product obsolescence seen in a large number of industries, particularly those producing goods that use ICTs, exerts pressure on the GPNs to constantly upgrade the technologies of their suppliers (Bernhardt and Milberg, 2011). This in turn provides opportunities for GPN suppliers to upgrade their technological knowledge on a regular basis.

Thirdly, irrespective of the nature of GPNs (i.e. whether they are producer-driven or buyer-driven), core firms in the GPNs are able to influence the production processes of their suppliers by actively transferring knowledge in the form of blueprints and technical specifications. The objective is to ensure that the suppliers meet the technical standards of the final products of the network.[12] GPNs are also able to encourage firms participating in the networks to access knowledge indirectly through other mechanisms, such as by helping them to import sophisticated equipment to improve their production capabilities.

Fourthly, the maturing of production networks in recent years has also resulted in some changes in the pattern of knowledge acquisition. Firms in GPNs have been introducing innovations that have moved them up the value chains thereby gaining more scope to operate independently. This relates primarily to firms moving up from manufacturing (as original equipment manufacturers (OEMs)) to become innovators in design, thereby assuming some responsibility for own design and manufacturing (ODM), and then finally branching out to market their own designs under their own brands that are of the quality of the original brand manufacturer (OBM).

However, ongoing experiences of developing-country firms that participate in GPNs

shows that successful GPNs tend to contract and rely on local suppliers who have both the capabilities to absorb the knowledge disseminated by the networks and meet the standards of production required by them. A considerable proportion of the production, exporting and innovation of this kind are occurring in only a few developing countries, particularly the emerging countries. Participation in GPNs also account for a significant share of South-South exports of technology-embodied goods and imports of capital goods. Making use of the technology upgrading opportunities that exist within GPNs, especially those that allow them to progress from manufacturing to designing and onto becoming original brand creators, a large number of firms in emerging developing-countries are also increasingly becoming originator firms of GPNs in many sectors. These emerging capabilities are being supported by growing R&D investments domestically, and a greater share of patents and earnings from royalty and licensing fees in their countries. As a result of these mutually reinforcing factors, a number of emerging countries have witnessed large-scale growth of certain sectors and a rise in the number of their own TNCs. Some Asian LDCs are trying to follow a similar path. One example is the textiles and readymade garments industries in Bangladesh.

3. The rise of developing-country TNCs

Along with the growing ability to export and produce competitively, there has been a rise in the number of firms from developing countries that are involved in major global mergers and acquisitions (M&As) in a wide range of sectors and countries since the mid- 2000s (table 2.11). Estimates show that by the year 2007, the total value of these firms' acquisitions reached nearly $145 billion, accounting for about 14 per cent of all acquisitions worldwide. More than 65 per cent of the acquisitions involved firms from the Asian region (UNCTAD, 2011a).

Table 2.11: Mergers and acquisitions globally and by firms from developingcountries, 1990–2011

	World	Developing countries	Share of total by firms from developing countries
	($ billion)		(Per cent)
1990	98.9	7.6	7.6
1995	112.5	6.4	5.6
2000	905.2	57.6	6.4
2005	462.3	68.7	14.9
2006	625.3	114.9	18.4
2007	1022.7	144.8	14.2
2008	706.5	105.8	15.0
2009	249.7	74.0	29.6
2010	338.8	96.9	28.6
2011	584.9	103.6	17.7

Source: UNCTAD (2011a).

a. A regional perspective on developing-country mergers and acquisitions

In recent years, firms from major Asian economies, such as China, India and Singapore, have been taking over companies in developed countries, as highlighted by a number of huge corporate deals (see UNCTAD, 2011a, table II.4). Many of the firms involved in such M&A mainly aim to enhance their competitiveness and seek strategic assets. Indian and Chinese firms have often been attracted by various intangible assets, such as advanced proprietary technologies, brand names and distribution channels.

In the Latin American region, the share of intraregional deals in cross-border M&As has increased considerably since the early 2000s, from 5 per cent of the total cross-border M&A deals in the region during the period 1995–2002 to 36 per cent during the period 2003–2010 (UNCTAD, 2011a, table II.9).

The leading region for M&A activities in the South remains Asia. While firms from South, East and South-East Asia have engaged in

Making use of the technology upgrading opportunities that exist within GPNs...

...a large number of firms in emerging developing-countries are also increasingly becoming originator firms of GPNs in many sectors.

There has been a rise in the number of firms from developing countries that are involved in major global mergers and acquisitions.

M&A activities in different regions throughout the world, their West Asian counterparts have shown a preference for M&As in developed countries. West Asia's outward investment flows have been concentrated in a small number of companies, with 10 firms accounting for about 83 per cent of M&As between 2004 and 2010. Only three of these firms have sectoral specializations, while the others are holding groups or investment companies.

Asian firms played a marginal role in the Latin American M&A market until 2010. This is similar to what has been observed in the context of Asian FDI in Latin American manufacturing. Since 2010, however, the Latin American cross-border M&A market has witnessed a notable and unprecedented surge of investments by developing-country firms from the Asian region – mostly Chinese firms. Acquisitions by these firms amounted to $20 billion in 2010, accounting for 68 per cent of the total, which is more than three times the total accumulated acquisitions of Asian firms in the Latin American region over the previous two decades.

b. Sectoral composition of cross-border mergers and acquisitions

The leading region for M&A activities in the South remains Asia.

On a sectoral basis, even within these cross-border M&As, the services sector accounts for about 70 per cent of all accumulated outward FDI, as already noted. A large proportion of these M&As have to do with GPNs in financial services in East Asia. Outward FDI in financial services have also rebounded since the global financial crisis, the value of M&A deals more than doubling in 2010, to $39 billion. Market-seeking M&As in specific service industries, such as hotels, health services and telecommunications, have been increasing, targeting economies both in and outside East and South-East Asia.

M&As in the telecommunications sector have also been a focus in the past few years, their total value amounting to about $14 billion in 2010. Bharti Airtel (India) alone spent $10.7 billion to buy the mobile operations of the Kuwaiti firm, Zain, in Africa.[13] A large number of acquisitions by Chinese firms have been in the oil and gas industry. The Chinese state petroleum company (Sinopec) has made upstream acquisitions in Brazil amounting to $7.1 billion (ECLAC, 2010). Similar investments have been made by Chinese companies (CNOOC and Sinochem) in other Latin American countries, notably Argentina. India was also the source of significant resource-seeking acquisitions in the region, especially in the oil and gas industry in the Bolivarian Republic of Venezuela and in the sugar cane industry in Brazil.

D. CHAPTER SUMMARY

Technology and innovation are both embedded features, and there is no single indicator that measures them holistically. Decades of academic and policy research on how to measure them have identified FDI, imports of capital goods, export capacity, R&D investments, education, patenting and licensing trends, researchers per million people, infrastructure and ICTs as the key variables that could be used to deduce technological learning and collaboration. This chapter has employed FDI, imports of capital goods, export capacity and participation in GPNs to assess trends in ongoing South-South exchange. In addition, trends in R&D investments, education, patenting and licensing trends, researchers per million people and infrastructure and ICTs have been presented to understand the underlying causes for varying technological capacity of developing countries and its implications for South-South technology-based exchanges.

The following points sum up the key findings of this chapter.

(i) Developing countries have surpassed developed countries as major partners of other developing countries for trade in capital goods. These imports are not only inputs for the expanding economic activities and consumption patterns in these countries, but point towards a trend where some

emerging countries are beginning to manufacture several high-technology products at competitive (and often lower) prices, which are leading to a shift in imports of the South from developed countries to developing countries. Imports lead to technological learning when firms possess the absorptive capacity to adapt and use the technologies embodied therein to generate productivity growth.

(ii) Within the current patterns of trade in capital goods imports, a few dominant trends emerge. The technological empowerment of the South is concentrated in only a few countries, mainly in East Asia as well as some newly emerging countries such as Brazil, China and India. These countries account for most of the South-South exchange of capital goods as a result of their growing technological capabilities, large and increasingly affluent consumer markets and their growing ability to absorb new technological knowledge.

(iii) While some South-South technological collaboration is evident, two important aspects stand out. Many developing countries, particularly LDCs, are currently limited by the lack of intrinsic technological capabilities required to benefit more from ongoing South-South exchanges. This is reflected in the lower demand for capital goods in non-oil-exporting LDCs, and their inability to participate in the growing GPNs of the South. Secondly, the South is contributing to increasing commodity dependence of the LDCs, which reduces their ability to structurally diversify their economies.

(iv) FDI by developing countries and their increasing participation in GPNs and M&A activities in the South are largely concentrated in emerging countries. While South-South FDI outflows are directed to a wide variety of sectors, including services and health, they tend to be concentrated in specific activities involving exchanges among a few countries in those sectors. This shows that some developing countries are increasingly involved in mutually beneficial technological exchange. The analysis further shows that within the countries that account for the enhanced collaboration on technology and innovation, increasing technological transactions through various means including participation in GPNs in the South, along with supportive innovation policy frameworks (that are increasingly focused on promoting higher tertiary education, as reflected in the growing number patents and of scientific and technical articles published in specialized journals) are leading to further strengthening of their innovation capacity.

NOTES

1. Of particular significance are rules relating to IPRs, which restrict the ability of firms in emerging countries to produce local generic versions of patented products.
2. A similar trend is observed or East Asia in the period 2000-2005.
3. South Asia and South East Asia both account for the highest share of intra-South trade, at 66 per cent each. India accounts for the largest share of intra-South trade among individual countries. This is the same in the case of capital goods imports.
4. In the analysis, capital goods include the machinery and transport groups and professional and scientific instruments based on SITC Rev. 3.
5. This may be explained by the explicit investments being made in developing production capacity in pharmaceuticals and agriculture in many developing countries as a result of local public concerns.
6. For the increase in exports, see Annex table A.II.6.
7. See Annex table A.II.11.
8. It should be noted that in the 1970s, two African countries (South Africa and the Libyan Arab Jamahiriya) accounted for most of the outward FDI from Africa.
9. See also annex table A.II.14.
10. UNCTAD (2010a) estimates that agricultural employment (as a percentage of total employment) declined from 69.83 per cent in 2000-2002 to 66.77 per cent in 2006-2008, and agricultural value-added (as a percentage of GDP) shrank from 30.66 per cent in 2000-2002 to 26.81 per cent in 2006-2008.
11. See, for example, Katz (1987), Dahlman, Ross-Larson and Westphal (1987), and Gutkowski, Rodrigues and Goity (1987).
12. For example, in managing the buyer-driven networks, branded marketers like Nike and Reebok, maintain close control over their suppliers by setting standards, sourcing raw materials, distributing them and finally importing the finished products.
13. Through this deal, Bharti Airtel gained access to mobile markets in 15 African countries, making it the world's fifth largest mobile telecoms operator in terms of number of subscribers.

3 ASSESSING ONGOING SOUTH-SOUTH TECHNOLOGICAL COLLABORATION

CHAPTER III

ASSESSING ONGOING SOUTH-SOUTH TECHNOLOGICAL COLLABORATION: EXAMPLES AND POLITICAL INITIATIVES

A. INTRODUCTION

Building further on the trends analysed in chapter II, this chapter assesses ongoing South-South technological collaboration based on several examples. Such collaboration can be broadly divided into the following three categories: public-sector-based, private-sector-based and public-private partnerships (PPP). The latter often consist of hybrid forms of private and public sector engagement. As this chapter shows, depending on the partners involved, the motives for collaboration may vary, ranging from simple scientific cooperation to more sophisticated forms of technology and innovation capacity-building involving technology transfer. With regard to sectors, most cases involve collaboration in health, agriculture and RETs, though there are also examples in manufacturing and infrastructure.

This chapter presents examples of the three categories of South-South technological collaboration described above. Section B describes some joint-venture initiatives between firms in the pharmaceutical and biotechnology sectors and in RETs. Section C presents specific cases of public-sector-led South-South collaboration and how these figure within the development assistance initiatives of countries. The examples have been chosen on the basis of information available on the technology and innovation parameters of the collaboration agreements. They seek to provide an understanding of how the collaborations contributed to technological learning, and the key contractual arrangements and policy incentives that facilitated this process.

A wide range of government and intergovernmental initiatives have emerged over the past decade, which focus particularly on agenda-setting for collaboration on technology and innovation and are aimed at setting policy targets at the national, regional and international levels. Section D discusses these various initiatives, including the BRICS Summit and the IBSA forum, as well as regional developments within the African Union (AU) and the New Partnership for Africa's Development (NEPAD). The chapter ends with a discussion of the key features of each of these initiatives and what they could mean from an overall perspective for technological learning and the building of innovation capacity.

B. INTER-FIRM TECHNOLOGICAL COLLABORATION

The most common forms of inter-firm technological collaboration take place through the transfer of skilled personnel, licensing agreements, subcontract manufacturing, and joint-venture initiatives. There are a number of motives that drive firms to enter into collaboration agreements, including the search for cost efficiency by moving all or some of their production to developing countries, as well as the search for new or expanded market opportunities in those countries or in regional groups (see also, Hoess and Vallejo, 2012). For the collaborating firms, the motivations for collabo-

The motives for collaboration may vary, ranging from simple scientific cooperation to more sophisticated forms of technology and innovation capacity-building involving technology transfer.

ration include their desire to enhance their technological capabilities in order to promote innovation, improve their competitiveness and meet public demand for specific products/services. As discussed in chapter II, inter-firm collaboration can take the form of either vertical collaboration between firms along the value chain (that is, between the producer and its suppliers) or horizontal collaboration.

Technological collaboration is particularly prominent in the pharmaceuticals sector. Potential production barriers due to most developing countries' obligations to comply with provisions of the TRIPS Agreement is a major motivating factor that drives their firms to expand production by collaborating with firms in LDCs that are exempt from immediate compliance (e.g. the joint venture between an Indian and Ugandan firm discussed below).

1. Pharmaceuticals and health care

Technological collaboration is particularly prominent in the pharmaceuticals sector.

This section presents three examples of technological collaboration in the pharmaceuticals sector. In the examples for both Ethiopia and Uganda, the governments, acting through their investment authorities, offered incentives that were critical for the joint ventures to materialize. In the Egyptian case, the government also played a key role in facilitating the joint venture, which involved technology transfer. Some other ongoing work is captured in box 3.1.

a. Uganda: Joint venture between Quality Chemicals (Uganda) and Cipla Pharmaceuticals (India)[1]

Quality Chemicals, a Ugandan pharmaceutical company, was a local distributor of imported drugs. In 2009, it entered into a joint venture with the Indian company Cipla Pharmaceuticals to produce drugs for the treatment of HIV/AIDS and malaria. By 2010, it was exporting to regional markets in Burundi, the Democratic Republic of the Congo, Kenya, Rwanda and the United Republic of Tanzania, as well as supplying the Ugandan Ministry of Health through a public procurement contract. Today, it has become the largest producer of antiretroviral (ARV) and anti-malarial drugs in Uganda.

The joint venture is of particular significance for public health in the domestic and regional markets because of its focus on the production of good quality drugs at affordable prices. It was the result of incentives provided by the Ugandan Government as part of its policy to build production capabilities for drugs of particular importance to that country's public health. Incentives included free land, an initial investment as part of Quality Chemicals' local equity (of up to 27 per cent), and a full purchase commitment for all drugs produced by the facility for the first seven years.

In return, Cipla was to provide the design for the production plant, which is based in Luzira (near Kampala), and a range of hardware technologies required for producing the drugs. These included manufacturing and testing technologies, information on the sourcing of raw materials and packaging technologies. The Government of Uganda provides the salaries of Cipla experts from India for conducting the skills transfer for a period of 3–5 years, which is an extra incentive for technological collaboration through the joint venture.

The main focus of the joint venture is on know-how and skills training provided by Cipla, which is essential for ensuring the sustainability of the venture and also for promoting entrepreneurship in Uganda. The joint venture envisages providing not only technical training to scientists and chemists, but also training on organizational matters to management personnel. Skills and know-how that have been transferred over the past two years relate to: (i) plant design and installation, (ii) product and process know-how, (iii) good laboratory practices, (iv) plant maintenance, and (v) sourcing of raw materials. Skills are transferred on the job in a day-to-day interactive environment as well as in regular weekly teaching sessions in a dedicated on-site classroom.

b. Ethiopia: SEAA – a joint venture with Chinese firms[2]

Established in 2001, SEAA is a joint venture company in Ethiopia operating in the pharmaceutical sector. The joint venture

involves three partners: one Ethiopian company, which originally focused on the import and distribution of pharmaceutical products in Ethiopia, and two Chinese companies, which specialize in the production of pharmaceutical products, medical devices, as well as equipment and machinery for pharmaceutical manufacturing.

Currently, as a result of the joint venture, SEAA is engaged in the manufacture and marketing of empty hard gelatine capsules (EHGC) in Ethiopia.[3] The technology associated with EHGC production consists of the capsule-making machinery and a number of other processes and related know-how for the different stages of production. Through this joint venture, all these technologies were transferred along with related know-how.

The Chinese partners supplied the machinery and equipment, as well as most of the technology and expertise. Chinese engineers provided training to the Ethiopian staff in handling, operating and mastering the technology and know-how involved in the manufacturing process. The plant is now operated by Ethiopian personnel, and the senior management and line staff of the joint venture are all Ethiopian.

Several government and market incentives supported this joint venture. The Ethiopian Investment Agency facilitated its establishment by arranging for the Oromiya Regional Government (where the plant is located) to provide the land and the facility at very low rent and on favourable terms. The absence of EHGCs in the domestic Ethiopian market, along with the potential for export to the regional market, provided a market incentive for the Chinese firms to establish the joint venture production facility in Ethiopia.

c. Egypt: VACSERA – a joint venture with Dongbao (China)[4]

VACSERA, a holding company for biological products and vaccines located in Giza, Egypt, forged collaborative ties with Dongbao, a Chinese firm, which enabled the transfer of technology for the production of recombinant insulin in Egypt. This was previously imported, and was often in short supply in the country. The joint venture has enabled local production of insulin in Egypt thereby giving diabetes sufferers in the country a reliable and readily available supply of insulin that is cheaper than the imported product. Local production of insulin has also resulted in substantial cost savings for the Egyptian Government.

2. Renewable energy technologies

Private sector technological collaboration in the area of RETs mainly takes the form of collaboration agreements that promote sharing of existing and successful RET-based applications, and training and capacity-building for upgrading human resources. In a few instances it may also involve joint R&D between firms. Such RETs-related technological exchange, such as in pharmaceuticals and health-related areas, is often facilitated by intergovernmental organizations or multilateral or regional development banks.

Private sector technological collaboration in the area of RETs mainly takes the form of collaboration agreements…

… and training and capacity-building for upgrading human resources.

Box 3.1: Inter-firm collaboration in health care and biotechnology

A recent study (Thorstendottier et al., 2010) interviewed 300 experts in 13 developing countries to estimate the extent of South-South collaboration in health-related biotechnology. According to the study, more than one quarter of health-related biotech firms in Brazil, China, Cuba, Egypt, India and South Africa have built linkages with firms in other developing countries, amounting to a total of nearly 280 South-South collaborations. Brazil alone reported more than 60 such arrangements. The study notes that as a result of rising technological capacity in several developing countries, South-South collaborations in health and biotechnology account for 47 per cent of all ongoing collaborations.

The study notes that these collaborations have enabled the recipient countries, such as Egypt and Tunisia, to meet most (60–95 per cent) of their own drug needs today. The interviews conducted in the study point to many other collaborative ventures, such as a trilateral South-South-North consortium for clinical cancer trials and a South-South collaboration (between Brazil and Cuba) facilitated by the World Health Organization (WHO) for treating Africa's meningitis outbreak, among others.

Source: Thorstendottier et al., (2010).

In some other areas, there is a larger engagement of the private sector in response to specific incentives granted by governments. In addition, promising market prospects have played a role in the decisions of firms to enter into such joint ventures (IRENA, 2011). In South Africa, for example, China's Suntech Power Holdings signed an agreement in 2010 to develop solar photovoltaic (PV) capacity of up to 100 megawatts. The total investment of the project is estimated at between $350 and $400 million and involves a South African company as a local partner.

There are other examples of South-South collaboration, but it is difficult to determine whether they are purely for technological learning.

Similarly, the Indian firm Suzlon Energy established a factory in Tianjin, China in 2007 to manufacture rotor blades, generators, hubs and other wind turbine components. This partnership is estimated to be turning out a capacity equivalent to 600 megawatts per annum. It also includes a plan for setting up an on-site R&D centre. In addition, Suzlon has partnered with domestic investors for Chinese wind installations, and has recently opened a sales office in the Republic of Korea on the expectation of strong future sales in that country.

3. Summing up

This section has presented examples of private sector South-South technological collaboration focusing on the technological learning aspects of those collaborations. There are other examples of South-South collaboration in the existing literature, but it is difficult to determine whether they are purely for technological learning, and if so, what their main focus is and the kind of collaboration involved.

Several developing countries have been taking steps to establish development cooperation agencies, and have been broadening the focus to more comprehensive development programmes.

C. PUBLIC SECTOR TECHNOLOGICAL COLLABORATION

Over the past two decades, the number of developing countries providing official development assistance (ODA) has grown considerably. Several countries have been taking steps to establish development cooperation agencies, and have been broadening the focus from mainly technical cooperation to more comprehensive development programmes. The Organisation for Economic Co-operation and Development (OECD) estimates that in 1991 the 22 member countries of the Development Assistance Committee (DAC) provided about 94 per cent of all development assistance, while the non-DAC members contributed the rest. In the two decades since, DAC members continue to provide by far the largest share of ODA, although the amount of disbursements by non-DAC contributors has been increasing (box 3.2). Between 2000 and 2010, the total ODA provided by non-DAC members amounted to $9,135 million in 2011, up from $1,740 million in 2000.[5] Asia has several development partners, including Indonesia, Malaysia and Thailand, in addition to China and India. As noted in chapter I, many of these countries set up South-South collaboration arrangements already in the 1950s and 1960s as part of broader cooperation efforts among developing countries. However, increasingly, a variety of arrangements for development cooperation are beginning to emerge among developing countries.

1. Brazil

Brazil began providing development assistance in the late 1960s, but established itself as a donor when it officially established its technical assistance programme in 1978 (IDRC, 2007). Its development cooperation began with the Portuguese-speaking African countries, which remain a priority in Brazil's international cooperation (Kragelund, 2011). The Brazilian Cooperation Agency (ABC), set up under the Ministry of Foreign Affairs at the end of the 1980s, became the primary institution to coordinate the country's technical cooperation programmes.[6]

It is estimated that the largest share of Brazil's development assistance goes to 16 African countries,[7] although this is gradually expected to expand to include some Asian countries as well. The ABC's projects focus primarily on agriculture (19 per cent), health (14 per cent) and education (11 per cent),

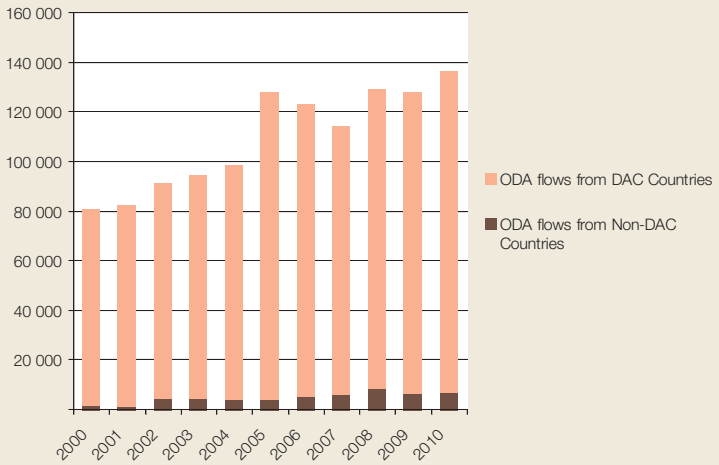
Box 3.2: Rising South-South official development assistance

The members OECD-DAC account for most of the ODA provided to developing countries. Although it is difficult to determine the exact amount of ODA provided by developing countries due to the paucity of data, it is known that such ODA is on the rise as shown in box figure 3.2.1. Countries such as Brazil, China and India, which are non-DAC donors, have been increasing their participation (OECD, 2010; UN-ECOSOC, 2008). According to available data, Saudi Arabia, China, the Bolivarian Republic of Venezuela, India and Brazil were the top five non-DAC donors in 2008, accounting for 79.1 per cent of the estimated ODA provided by the top 16 developing-country donors (OECD, 2010).

This trend has been reinforced by the economic development of the emerging countries and their geopolitical aspirations to contribute to South-South cooperation.

Source: UNCTAD.

Box figure 3.2.1: ODA from developing countries and from DAC members, 2000–2010 (at constant $ million as of 2010)



Source: OECDstat.

as well as on vocational training for industrial development in response to requests from countries in sub-Saharan Africa (World Bank and IPEA, 2011). In the agricultural and health sectors, Brazil's technical cooperation is conducted through local agencies such as the Brazilian Agricultural Research Corporation (Embrapa) and the Oswaldo Cruz Foundation (Fiocruz).The vocational training projects of ABC are conducted through Brazil's National Service for Industrial Training (SENAI). These are discussed in more detail below.

In addition to its bilateral programmes, Brazil also engages in several multilateral cooperation programmes aimed at promoting technical capabilities in African countries.[8]

a. Embrapa

The Brazilian Agricultural Research Corporation, Embrapa, is a State-owned enterprise under the Brazilian Ministry of Agriculture.[9] Traditionally, it has been responsible for providing feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer. With the expansion of Brazilian development cooperation, Embrapa has increased its presence in sub-Saharan Africa in recent years,[10] pri-

It is estimated that the largest share of Brazil's development assistance goes to 16 African countries.

In addition to its bilateral programmes, Brazil also engages in several multilateral cooperation programmes aimed at promoting technical capabilities in African countries.

marily through three components: "structuring projects", technical training, and the Africa-Brazil Platform for Agricultural Innovation (World Bank and IPEA, 2011). Working with ABC, Embrapa currently has 78 bilateral agreements with 56 countries and 89 foreign agencies, especially in agricultural research. This primarily involves technical cooperation in the form of research partnerships and/or technology transfer.[11] Given Embrapa's growing international activities, the agency is expected to launch an international arm, Embrapa International, in 2012.[12]

The examples in boxes 3.3 and 3.4 below highlight two of Embrapa's structuring projects in Africa. Such projects are customized to local needs, and coordination takes place through consultations with local stakeholders. ABC intends to help promote long-term social development in partner countries through capacity-building activities.[13]

A joint African-Brazil initiative, the Agricultural Innovation Marketplace was launched in 2010 to strengthen ties between Embrapa and African researchers. Joint projects involve a total of 125 agricultural specialists from 15 of the sixteen African countries (listed above) that receive development assistance from Brazil.[14] The main themes of the projects currently funded include: fostering knowledge-sharing for integrated natural resource management in Southern Africa (Mozambique); sweet sorghum varietal adaptation for ethanol production (Kenya); rehabilitation of degraded rangelands using planned grazing in arid and semi-arid lands (Kenya); prevention of pesticide leaching and loss of groundwater in coastal vegetable cultivation (Togo); development of cotton varieties and pest management (United Republic of Tanzania); enhancing the ecology and the nutritional potential of native food tree species used by local communities (Burkina Faso and the Brazilian Amazon); and developing a food security and conservation strategy in the context of climate change (Burkina Faso).

b. Oswaldo Cruz Foundation

The Oswaldo Cruz Foundation (Fiocruz), a government-funded health research organization, is engaged in various international cooperation initiatives, particularly in Latin America and in Portuguese-speaking African countries. Part of the Brazilian Ministry of Health, the Foundation aims to support and promote activities in health, education and scientific and technological development.[15] Fiocruz has emerged as a national and regional pioneer in health-related R&D, production of vaccines, reagents, drugs and diagnostics; human resource training; information-sharing; quality control; and im-

Box 3.3: The four-country cotton project

Launched in 2008, this project aims to support the development of the cotton industry in the "C-4 countries" – Benin, Burkina Faso, Chad and Mali. The initiative has a strong capacity-development component. It aims to:

- Provide tools for the governments in all four countries to enable them to develop an autonomous cotton industry. For example, nine Brazilian cotton varieties developed by Embrapa over the past 20 years are being tested and adapted in Mali (ABC, 2010);
- Transplant Brazilian technologies for increased profitability and quality, given the similarities in soil and climatic conditions in the four countries and Brazil; and
- Improve the quality of life and food security of farmers.

Through this project, Mali has constructed a laboratory for biotechnology at its experimental station, which is financially supported by ABC in the country. Another laboratory, for biological control, will be built by Embrapa, also with financial support from ABC. These projects are expected to help incorporate plague management in the production process in all four project countries.

As part of this project, 56 researchers from the four countries have participated in technical training on genetic improvement of cotton and other related areas. An important aim of the project is to integrate the different components of an agro-ecosystem to promote the rational utilization of natural resources.

Source: ABC (2010).

Box 3.4: Project for the development of rice culture

This is Embrapa's third project in Senegal, jointly developed by the Senegalese Institute for Agricultural Research (Institut Sénégalais de Recherches Agricoles) and Embrapa's rice and beans unit in Brazil. Initiated in 2010 at a cost of $2.4 million, its aim is to assist and transfer technology to Senegal as it moves towards self-sufficiency in rice production by improving efficiency. Activities include applying production technologies, providing training and capacity-building to Senegalese practitioners, and experimenting with 10 different varieties of rice developed by Embrapa's rice and beans unit for irrigated cultures at intermediate elevations and in the highlands.

This project is strategically important because rice is a basic staple of the Senegalese diet: average annual consumption is 74 kg per person compared with 44 kg in Brazil.

Source: World Bank and IPEA (2011).

Box 3.5: Fiocruz-Mozambique ARV production facility

Among Fiocruz's joint projects with other developing countries, the Fiocruz-Mozambique ARV production facility has received much attention. Under this initiative, Fiocruz is currently supporting the establishment of a $21 million factory for the production of ARV drugs for the treatment of HIV/AIDS in Mozambique. This initiative for the development of affordable ARV drugs in Mozambique was based on the successful experiences of two of Brazil's domestic HIV/AIDS health programmes.[a] The goal is to reduce Mozambique's dependence on donors and to increase health partnership opportunities in Africa.[b]

The project has been extended by several years, and production is expected to start in late 2012 with full technology transfer expected to take place by 2014.[c] Several other Brazilian institutions, particularly SENAI, are involved in providing equipment and staff training.

Source: UNCTAD, based on various sources.

[a] *The first was the AIDS control programme financed by three World Bank loans ($160 million in 1993, followed by $165 million in 1998, and an additional $100 million in 2003) (World Bank, 2004). The second was a generic drugs policy initiated in 1999, which allowed Brazilians to purchase drugs at more affordable prices and quality assurance.*

[b] *It is expected that the facility will have the capacity to produce 226 million ARV tablets and 145 million units of other medicines annually for domestic supply and provision to other African countries.*

[c] *Based on GHSi (2012), p. 26.*

plementation of social programmes (GHS Initiatives, 2012).[16] Building on its experiences with technology assimilation, Fiocruz is gradually expanding its engagement in developing technologically innovative capacities in health care in other developing countries (box 3.5).

c. SENAI

The Brazilian National Service for Industrial Training (SENAI) was created in 1942, and is currently funded through mandatory contributions from local private enterprises.[17] SENAI imparts vocational training to meet Brazil's industrial requirements. Based on its previous experiences, it has now joined other Brazilian institutions as a provider of international technical assistance. It has 48 international partnerships with 25 countries, which have so far led to 29 projects, 5 of them in sub-Saharan Africa. With the ABC, SENAI has set up 10 vocational training centres globally, 5 of which are in Africa (Angola, Cape Verde, Mozambique, Guinea-Bissau, and São Tomé and Príncipe), and 2 others are being opened in South Africa and Angola. For example, the Brazil-Angola Vocational Training Center in Cazenga supported national reconstruction through training and rehabilitation of the demobilized labour force as Angola's 40-year civil war wound down. Between 1999 and 2006, it trained more than 3,000 Angolans in fields such as diesel mechanics, civil construction, apparel making and information technologies (World Bank and IPEA, 2011).

2. India

India's flagship programme on technical cooperation can be traced back to 1964 when it sought to help meet the needs of its partner countries through bilateral engagements via the India Technical Economic Cooperation (ITEC) programme. It was initially launched as a cooperation initiative for newly independent countries, particularly members of the Commonwealth. The ITEC programme is based in the Ministry of

External Affairs, and includes the following components: training and capacity-building, project cooperation, and the provision of technical assistance by Indian experts.[18]

India's cooperation projects are implemented through bilateral, multilateral or regional agreements...

India also engages in South-South technological collaboration via the International Cooperation Division of the Ministry of Science and Technology. Cooperation projects are implemented through bilateral, multilateral or regional agreements for facilitating and strengthening interactions among governments, academia, institutions and industries in areas of mutual interest. India currently has bilateral science and technology cooperation agreements with several developing countries.[19] These focus mainly on the facilitation and enhancement of bilateral trade with other developing countries, and many have a technology learning component. A significant number of them take place in Africa. Some of the key initiatives are the Focus Africa Programme, the IBSA Initiative and the Techno-Economic Approach Movement (TEAM-9): West Africa. All of these initiatives include components for technological collaboration (box 3.6).

...for facilitating and strengthening interactions among governments, academia, institutions and industries in areas of mutual interest.

Some examples of publicly funded technological collaboration initiatives as part of India's South-South cooperation commitments are described below.

a. India-Pan Africa e-Network Technical Collaboration and Knowledge Sharing

The Pan-African e-Network Project is an initiative led by the Indian Government, undertaken in partnership with the 53 members of the AU. Launched in 2007, initially for a period of five years, its objective is to empower the African continent through telemedicine and tele-education. This project is among the largest programmes of distance education in telemedicine ever undertaken. It seeks to provide educational facilities and affordable health care in recipient countries.

The collaboration covers the cost of supply, installation, testing and commissioning of hardware and software, end-to-end connectivity, satellite bandwidth, support services, and the provision of tele-education and telemedicine services to 53 African countries for a five-year period. Each African country signing up to the initiative designates an implementing agency to Telecommunications Consultants India Limited (TCIL), which is the implementing agency of the project. They also designate a central hospital as well as a centre for e-learning (UNDP, 2009).[20] The first phase of the Pan African e-Network Project has been implemented in 11 countries since 2009.[21]

Box 3.6: India's recent initiatives for technological collaboration

India's three key initiatives focusing mainly on aspects of technological collaboration are described below.

The Focus Africa programme was launched under the Export Import Bank of India (EXIM Bank), and was implemented between 2002 and 2007. Particular emphasis was sought to be given to providing assistance for African exports of specific products, particularly textiles, pharmaceuticals, machinery and instruments, transport equipment and information and communication technologies (ICTs).[a]

The IBSA initiative, a trilateral initiative between India, Brazil and South Africa, forged the New Delhi Agenda for Cooperation and Plan of Action, which aims to enhance trilateral trade and cooperation between the three countries. It includes technological collaboration in pharmaceuticals and health care, ICTs, civil aviation and defence (see section D of this chapter for more details).

The Techno-Economic Approach Movement (TEAM-9) is an initiative focused on enhancing commercial ties between West African States and India. It envisages sharing various types of technical expertise and technological and financial resources. As part of this initiative, specific projects have been undertaken in key sectors, and a credit line of $500 million has been extended through the EXIM Bank of India for financing these projects (Humphrey, 2011). The initiative is expected to encompass education, training and relevant technology transfer in sectors such as agriculture, small-scale industries, pharmaceuticals and health care, and ICTs.[b]

Source: UNCTAD, based on various sources.

[a] *See: Indo-African Chamber of Commerce and Industries, at: http://www.indoafrican.org/Indias%20Iniatied.pdf.*

[b] *See: Indo-African Chamber of Commerce and Industries.*

b. India's collaboration on human genome sequencing

In 2003, India became one of the first developing countries to be involved in developing a database on human genome sequencing. The initiative was undertaken by the publicly funded Institute for Genomics and Integrated Biology (IGIB) of the Council for Scientific and Industrial Research (CSIR). It was mandated to establish a network of institutions – the Indian Genome Variation (IGV) consortium – driven by science and technology institutions in India. Since then, the Indian Government has sought to use the knowledge generated by the programme in its collaboration with other developing countries. For instance, a collaborative venture in Sri Lanka, led to the generation of the first Sri Lankan human genome, which was successfully sequenced by scientists and bioinformaticians from the University of Colombo, Sri Lanka, and the Institute of Genomics and Integrative Biology, New Delhi, India.[22,23]

c. India's collaboration on RETs development

As one of the forerunners in the RETs sector among developing countries, particularly in solar and wind power, India has experience in using semi-grid and off-grid applications for helping to alleviate rural poverty. The example of the Lighting a Billion Lives initiative (LaBL) demonstrates the Government's approach in promoting solutions to the provision of electricity in remote areas and in sharing this successful experience with other developing countries. This initiative has now been scaled up for wider application in other developing countries.

The LaBL initiative was launched in 2008 by the Energy and Resources Institute (TERI), an international think tank that is supported by the Government of India. Using an entrepreneurial model, it seeks to deliver energy services through the provision of high-quality, cost-effective solar lanterns that are disseminated through solar charging stations set up in non-electrified or poorly electrified villages.[24] The operation and maintenance costs are borne by the users of the solar lanterns in the form of the rent they pay to the operators of the charging stations, while the capital cost of setting up the charging station in the village is raised by TERI through government agencies, corporate donors and communities. Since the initiative was launched in 2008, around 35,000 rural households in India have replaced their kerosene lamps with clean and environmentally friendly solar lanterns (for more details, see UNCTAD, 2011c).

India currently has bilateral science and technology cooperation agreements with several developing countries.

The initiative has also formed a basis for South-South collaboration through training and capacity-building programmes, technology transfer initiatives, piloting of successful delivery models and identification of local partners for replicating and scaling up the model in various developing countries. In Uganda, for example, LaBL is being expanded through local partnerships developed in collaboration with private distribution networks in the country. Several international donors, such as the United States Agency for International Development (USAID), UN-HABITAT, and the United Nations Industrial Development Organization (UNIDO), are supporting the expansion of the initiative in other developing countries.

3. China

China's activities in development cooperation take many forms, and spending related to those activities often does not follow DAC reporting guidelines, so that the estimates vary considerably. Chinese development cooperation activities, which are closely linked to trade and investment, are spread across different government ministries, including the Ministries of Foreign Affairs, Commerce, Finance, Health and Education. The China Development Bank and the China Export Import Bank provide the financing in cooperation with the relevant ministries.

Chinese development cooperation activities are spread across different government ministries.

China's South-South technological collaboration covers a variety of areas, including

agriculture, oil and gas, and infrastructure development such as construction and telecommunications. China also has technological collaborations with some emerging countries. A recent example is the strengthening of its scientific and technological collaboration in agriculture with South Africa (box 3.7).

China's South-South technological collaboration covers a variety of areas, including agriculture, oil and gas, and infrastructure development.

a. Chinese-Angolan ICT infrastructure development collaboration[25]

Huawei Technologies, a Chinese ICT firm, is contributing to the development of infrastructure for Angola's operators in wireless technology and new generation networks. This collaboration, funded by China's EXIM Bank, has led to the installation of optical fibre cables in Luanda and it is expected to expand to other provinces as well. Huawei Technologies has invested the requisite finances to transform the former *Instituto Nacional das Telecomunicaçoês* (ITEL) into *Universidade de Telecomunicações*, as well as build a new Telecom Technical Training Centre. The training centre is based on a model that the Chinese company has employed in five other African countries, namely Kenya, Nigeria, South Africa, Tunisia and Uganda. Besides the training Angolan recruits receive at home, staff exchanges between China and South Africa are envisaged in order to promote the transfer of tacit know-how. Angola's Ministry of Communications is closely involved in the collaboration.

b. Lighten up Africa Project: an example of collaboration between China, 10 African countries and UNIDO[26]

This project involves cooperation between the China International Centre for Economic and Technical Cooperation (CICETE) under the Ministry of Commerce (MOFCOM) and the International Centre for Small Hydro Power (IC-SHP), a member institution of the China South-South Cooperation Network. It is the culmination of many rounds of consultations with UNIDO and a number of African governments. One of the key objectives of this project is to set up 100 mini-hydropower stations in remote rural areas of 10 African countries – Cameroon, Ethiopia, Kenya, Liberia, Mali, Nigeria, Sierra Leone, Uganda, Zambia and Zimbabwe – to provide power to rural Africa. It is expected to benefit 100,000 people (UNDP, 2009).

4. Mexico

In 2011 the Mexican Government issued the International Development Cooperation Law (LCID). This law institutionalizes for the first time a national system of international development cooperation within the Mexican public policy framework (SEGOB, 2011).[27] It explicitly highlights the need to engage in development cooperation activities in developing countries. This includes cooperation in the areas of environmental protection and sustainable development, and the improvement of technical, scientific

Box 3.7: Cooperation between China and South Africa in agriculture

At the China-South Africa Agricultural Cooperation Forum in 2011, the two countries agreed to reinforce scientific and technological collaboration in four key areas in the agricultural sector.

First, joint research on maize planting and cultivation techniques suited to South Africa's local conditions is planned to be carried out in order to overcome the problem of the relatively short supply of new maize varieties and supporting cultivation techniques. Second, joint research is expected to improve on animal breeding techniques through the sharing of knowledge and experiences. Third, dryland farming and water-saving irrigation techniques will be promoted in response to local conditions and requirements. Fourth, it is expected that both countries will pursue joint training in agricultural technology on a bilateral basis. In the light of South Africa's deficiencies in economic and educational development and workforce training, after taking language training at home, Chinese agricultural specialists and young and middle-aged professionals are expected to be selected and sent to South Africa to provide technical training to local workers. This is part of the objective to accelerate the application and dissemination of China's (Jilin Province) technological know-how in South Africa in order to deepen collaboration between the two countries.

Source: Forum on African Cooperation (available at http://www.focac.org/eng/zfgx/t851767.htm).

and cultural education through the collaborating entities, among other developmental issues (SEGOB, 2011). The LCID provides two instruments for international development cooperation: the Mexican International Development Cooperation Agency (AMEXCID) and the International Development Cooperation Program (PROCID). The agency has the mandate to direct, coordinate and implement Mexican policy for international cooperation with a view to improving integral human development and sustainable growth predominantly in the Latin American and the Caribbean region. In this region, about 48 per cent of the projects implemented are in South America, 38 per cent in Central America and 14 per cent in the Caribbean (SRE-AMEXCID, 2011).[28] The programme is responsible for the planning and implementation of all of Mexico's development strategies and actions, and for defining and establishing the objectives and strategic areas for Mexican cooperation.[29]

As a member of the OECD since 1994, Mexico is also an observer member of the OECD-DAC, where it has enhanced its role as an emerging donor. Mexico is also active in the United Nations Development Assistance Framework (UNDAF) and in the G20 Development Working Group.

Within Latin America, Mexico has technological collaboration projects with Argentina, Brazil, Chile, Colombia and Uruguay in nano- and biotechnologies among other areas. In Argentina, projects include aspects of climate change mitigation and the creation of nano- and biotechnology centres in addition to national parks administration, infectious disease control, dental health, inspection systems and industrial development.

Mexico has also been innovative in creating newer methods and instruments of development cooperation. One such instrument is the joint Mexico-Chile Fund that finances development projects in a number of countries in the region, including Bolivia, Ecuador and Uruguay (box 3.8).

Mexican development cooperation includes cooperation in environmental protection and sustainable development, and the improvement of technical, scientific and cultural education.

Some other interesting examples of Mexico's South-South technological collaborations, presented below, demonstrate a focus on capacity-building for technological absorption through training sessions and educational exchange programmes, particularly with other countries in the region.

a. Programme for strengthening capacities for the development of technological projects in aquaculture

The Mexican Scientific Research and Higher Education Centre of Ensenada (CICESE) and the Catholic University of Peru conducted a series of consultations and exchange programmes in 2007-2008 as part of the programme for the Strengthening of Capacities for the Development of Technological Projects in Aquaculture. Under the programme, a team of engineers from the Peruvian partners were trained in assimilation, adaptation and application of precision technologies at different levels of international supply chains of the main exportable species in Peruvian aquaculture. The programme covered all stages of the production chain, as well as its linkages with other productive sectors.

Mexico has also been innovative in creating newer methods and instruments of development cooperation.

Box 3.8: The Mexico-Chile Fund

The Mexico-Chile Fund is an innovative mechanism of South-South collaboration in areas of priority. In 2011, it financed 8 projects: 3 in environment, another 3 to boost the competitiveness of SMEs, 1 in public management and another in conserving the historic patrimony. These projects were sponsored by the fund in several countries of the region, including Ecuador, Bolivia and Uruguay. Projects with Ecuador involving training in models and tools for hydro-informatics, potable water management and for setting up rural micro firms. In Bolivia, the areas targeted include food, textiles, wood manufacturing and community tourism. Cooperation with Uruguay involves agriculture, health, social development, science and technology, environment and education.

This fund could potentially be replicated in many other countries, or more generally within South-South collaboration for technology and innovation.

Source: UNCTAD, based on various sources.

b. Development of biosecurity protocol in laboratories, greenhouses and fields with genetically modified organisms in Peru

In order to develop biosecurity protocols in laboratories, greenhouses and fields for the cultivation of papayas, a series of training sessions were conducted during the period 2007–2010 involving the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), the Mexican Centre for Research and Advanced Studies of the National Polytechnic Institute in Irapuato, and the National Agricultural Innovation Institute of Peru. The main output of this collaboration was the creation of a protocol for providing information on the management of genetically modified organisms (GMOs) in various environments and on a set of best practices in this area. This protocol is expected to be part of a broader protocol creation exercise that Peru is undertaking within its national programme on biosecurity.

c. Course in non-destructive practices

The Mexican Engineering and Industrial Development Centre (CIDESI), with the support of the Japanese International Cooperation Agency (JICA), provides annual courses on methodologies of industrial non-destructive practices. Those participating in the courses include inspectors from technological development organizations in Argentina, the Bolivarian Republic of Venezuela, Colombia, Costa Rica, Chile, Panama, Peru and Uruguay. The participating instructors are offered certificates on completion of the courses, which has a positive impact in terms of strengthening industrial institutions in the participating countries.

5. Saudi Arabia

Saudi Arabia has been one of the largest non-DAC donors since 1973, with ODA amounting to $5,564 million in 2008.

Saudi Arabia has been one of the largest non-DAC donors since 1973, with ODA amounting to $5,564 million in 2008 – according to OECD data, an amount almost three times that of the ODA from China, the second-largest non-DAC donor (OECD, 2010).

Saudi Arabia's ODA comprises mainly project-type assistance, which includes some budget support and debt relief. Technical cooperation projects account for only 4 per cent of the total (Reality of Aid, 2010). Almost 95 per cent of Saudi Arabia's aid is provided bilaterally, mainly in the form of loans to neighbouring countries. Recently, assistance to South and East Asia has increased substantially, particularly to Bangladesh, China and Pakistan (Woods, 2008).

The sectors and projects targeted are transport and communications (45 per cent), followed by health (22 per cent), education (20 per cent), agriculture (10 per cent) and energy (3 per cent) (UN-ECOSOC, 2008). In recent years, Saudi Arabian ODA has begun to include some technology capacity-building components. For instance in 2011 Saudi Arabia signed an agreement with Viet Nam to build the Ninh Thuan Vocational Training Center, which aims to provide professional courses aligned with industry requirements. At this centre, 3,000 trainees are expected to graduate every year until 2015 (Saudi Fund for Development, 2011).

D. MAJOR GOVERNMENT INITIATIVES FOR SOUTH-SOUTH TECHNOLOGICAL COLLABORATION

The past two decades have seen a revival of interest in government-led initiatives from developing countries that focus on technology and innovation in the South.

Much in keeping with the ongoing bilateral activities on development cooperation and technical assistance highlighted in section C, the past two decades have seen a revival of interest in government-led initiatives that focus on technology and innovation in the South. These initiatives are conducted through regional, interregional and other institutional channels. The various initiatives can be viewed as part of a broader agenda in the policy arenas of the countries of the South. They are a reaffirmation of the growing recognition of the importance of greater collaboration on technology and innovation. This section seeks to present an overview of such initiatives.

1. Recent major intergovernmental initiatives

Over the past decade, in addition to bilateral development assistance, developing countries have strengthened their mutual commitment to foster South-South collaboration in various ways. Two recent developments are particularly noteworthy: the annual BRICS summits, and the IBSA forum, which are discussed here. Another example of an initiative to expand cooperation is the Istanbul Plan of Action (IPOA), which was the outcome of the Fourth United Nations Conference on the Least Developed Countries (UNLDC IV). It contains concrete recommendations and has led to a greater involvement of the Turkish Government as discussed below.

a. BRICS summits

Greater cooperation among BRICS members, including in the areas of science, technology and innovation (STI), is a central tenet of these countries, as emphasized at their most recent summit in Delhi. The Delhi Declaration highlighted the need to promote science and technology and related knowledge exchange amongst the members.[30] Recognizing the broader relevance of knowledge sharing, paragraph 40 of the Delhi Declaration states that there is a pool of "knowledge, know-how, capacities and best practices available in our countries that we can share and on which we can build meaningful cooperation for the benefit of our peoples".[31]

The specific sectors for cooperation set out in paragraph 43 of the Declaration include the priority areas of food, pharmaceuticals, health and energy, as well as basic research in emerging interdisciplinary fields such as nanotechnology, biotechnology and advanced materials science (box 3.9). The paragraph stresses the need to encourage the flow of knowledge amongst member countries' research institutions through joint projects, workshops and exchanges of young scientists. Paragraph 45 of the Declaration refers to their growing requirements for renewable energy resources, and also "energy efficient and environmentally friendly technologies", and the need to exchange knowledge and technology through their complementary strengths in these areas.[32]

There are also other ongoing collaborations among the BRICS countries, such as the Action Plan on Agriculture that was finalized in 2011 (box 3.9).[33]

b. The India-Brazil-South Africa Dialogue Forum

The IBSA Forum is not a formal arrangement or policy initiative, but rather, a grouping of like-minded States that share similarities in their stages of development. It is a platform for the three countries to structure their global engagement and coordinate their positions on key issues, including the promotion of development cooperation (Beri, 2008). IBSA is also expected to be an initiative through which these countries can collaborate with other developing countries, particularly LDCs.[34] The Brasilia Declaration of the Fourth IBSA Summit of 2010 includes provisions on South-South cooperation that emphasize the importance of technological cooperation.[35] They specify the modes of cooperation in science and technology as well as the mutually agreed areas for such cooperation.[36]

The Plan of Action for cooperation notes that the three countries agree to:

- Share information on best practices in technology transfer and to jointly consider IPRs issues related to the protection of biodiversity and traditional knowledge; and
- Promote networking among their R&D institutions in order to strengthen and further develop the trilateral science and technology relationship.[37]

c. The Istanbul Plan of Action and the Turkish Initiative

The Istanbul Plan of Action for LDCs (2011) that emerged from the UNLDC IV Conference held in May 2011 recognizes science, technology and innovation as an important element for development (Point 52). The plan acknowledges that LDCs require greater assistance in critical areas of STI, and that they mostly own outdated technologies as reflected in their production pro-

Three recent developments are particularly noteworthy: the annual BRICS summits, the IBSA forum and the Istanbul Plan of Action (IPOA).

Box 3.9: BRICS Action Plan to enhance technology cooperation and innovation in agriculture

The Action Plan 2012-2016 for Agricultural Cooperation of BRICS Countries presents the ways in which cooperation will be undertaken in the agricultural sector. The Plan recognizes as its fourth element the need to "enhance agricultural technology cooperation and innovation." This element is coordinated by India in collaboration with the other four member countries. The Action Plan contains the following recommendations:

1) Establish a strategic cooperation alliance on agricultural science and technology among the BRICS countries, and hold an agricultural technology cooperation forum alternately in the five countries every other year. The aim of the forum will be to strengthen dialogue and exchange, jointly analyse major challenges in agricultural technologies, and discuss how to share scientific and technological resources, promote the development of agricultural technologies and improve the efficiency of scientific research in the BRICS countries;
2) Hold a conference alternately in the five countries every other year to exchange views on agriculture, fisheries and aquaculture development trends and research priorities, and discuss cooperation on management, research and industry in the fields of agriculture, fisheries and aquaculture among the five countries;
3) Strengthen cooperation in resources and environmental conservation, including the development of biomass energy and crop residue recycling, and conduct discussions and exchanges on agricultural development and energy exploitation;
4) Conduct collaborative research on low-carbon fishery technologies, including technological development and collaborative research on energy savings and emission reductions of fishing vessels, the carbon sink function of aquaculture and artificial wetlands, and recycling of aquaculture systems;
5) Promote the sharing of views on strategic objectives that are desired to be reached by 2016;
6) Create an Innovation Projects Store;
7) Promote cooperation on technologies that could strengthen traditional forms of production for the maintenance of biodiversity;
8) Conduct dialogue and share research on dietary regimes with the aim of increasing diversity of food production;
9) Promote cooperation on the economy of ecosystems and biodiversity (TEEB) in order to strengthen environmental conservation in agriculture;
10) Cooperate on the sustainable use of water and fertilizers;
11) Hold seminars on policy concerning the adoption of frontier sciences in biotechnology;
12) Exchange germplasm resources (genetic resources, subject to national laws), conduct studies on the breeding of hybrid rice, hybrid maize, wheat, pulses, oil seeds, horticulture and other crops; demonstrate and promote conservation farming, soil improvement technology, balanced fertilization, new fertilizer sources and other yield-promoting technologies to increase the unit yield, and improve the quality of crops.

Source: http://www.bricsindia.in/actionPlan.html.

The IPOA proposes that LDCs and their development partners establish a technology bank and supporting mechanisms for STI which will focus on LDCs.

cesses and outputs. It therefore proposes that LDCs and their development partners establish a technology bank and supporting mechanisms for STI which will focus on improving LDCs' scientific research and innovation base, enabling networking among researchers and research institutions, and facilitating access to critical technologies. Paragraph 139 of the Istanbul Plan of Action emphasizes the promotion of access to technologies in LDCs through greater South-South collaboration in this area.

As part of the Istanbul Plan, a science, technology and innovation centre, to be called the International Innovation Network, was proposed by the Government of Turkey to address some of the shortcomings of existing initiatives on technology transfer.[38] The Network is intended to "…promote access of LDCs to improving their scientific and innovative capacity needed for their structural transformation."[39] It would serve as a real and virtual hub for, among others, "facilitating joint learning – through exchange of information and experiences as well as establishment of a shared knowledge base of analytically rigorous, shared case studies – to enable peer-to-peer learning between experts, organizations and agencies from LDCs and other countries with recent and ongoing development experiences."

2. Other government initiatives

A range of joint initiatives exist at the national and regional levels amongst developing countries, reflecting their efforts to promote collaboration. Although these are not focused entirely on technology and innovation, most of them clearly stipulate this as an area of cooperation. Some of the major initiatives are presented here.

a. Africa

Several regional integration agreements in Africa have provisions on technological collaboration. These include the NEPAD Science and Technology Plan, the AU technology development programmes, and provisions for science and technology collaboration in treaties of the African Economic Community (AEC), the Southern African Development Community (SADC) and the Economic Community of West African States (ECOWAS).

i. Africa's Science and Technology Consolidated Plan of Action

The AU has long been active in promoting technological collaboration within Africa (even within its precursor, the Organization of African Unity). In furtherance of these efforts, in February 2003, a group of African countries agreed to establish a Forum on Science and Technology within NEPAD to promote collaboration in these areas. The Consolidated Science and Technology Plan of Action (CPA), under design for several years, was finally adopted in 2005 by the African Ministerial Conference of Science and Technology. It outlines priority R&D programmes in the biosciences, water, material science and manufacturing, and ICTs. The CPA is structured around three core pillars: knowledge production, technological innovation and capacity-building (NEPAD, 2010). It contains aspects of implementation in its Section 5 and in the annex. However, experiences with implementation in different areas have been mixed, with some areas having more success in terms of practical action than others. One of the key components of the plan is the development of science and technology indicators through the African Science and Technology Indicators Initiative (ASTI), which has progressed somewhat. However, mechanisms for funding have been problematic, and the planned funding mechanism – an African Science and Innovation Facility – has not materialized.

In order to promote ownership of the plan by African countries and better implementation of the CPA's components, the NEPAD Programme has been converted into the NEPAD Planning and Coordination Agency. Its main tasks include the following (NEPAD, 2010):

- Facilitating and coordinating the implementation of regional projects;
- Mobilizing resources and partners to support implementation of Africa's priority programmes/projects;
- Conducting and coordinating research and knowledge management;
- Monitoring and evaluating the implementation of programmes/projects; and
- Offering advocacy services about the AU and NEPAD vision, mission and core principles/values.

A range of joint initiatives exist at the national and regional levels amongst developing countries, reflecting their efforts to promote collaboration.

NEPAD remains the key implementing institution for all of the AU's technological collaboration programmes to promote technology development.[40] In addition to this, the AU provides some forms of technological assistance through its Technology Development Programmes.[41]

NEPAD remains the key implementing institution for all of the AU's technological collaboration programmes.

ii. African Economic Community

The African Economic Community (AEC) Treaty of 1991 establishes the grounds for mutual economic development among the majority of the AU member States. Article 51 contains provisions on science and technology that stipulate mutual cooperation, including cooperation in "the development, acquisition and dissemination of appropriate technologies".[42] A plan of action developed to promote this goal includes a provision for member States to:

- Harmonize national policies on scientific and technological research;

- Coordinate programmes in applied R&D and technology services;
- Harmonize national technological development plans, and create an environment for technology absorption and regulation of industrial property and transfer of technology;
- Coordinate members' positions on all scientific and technical questions that arise in international negotiations;
- Carry out permanent exchange of information and documentation and establish AEC data networks and data banks;
- Develop joint programmes for training scientific and technological cadres, including the training and further training of skilled manpower; and
- Promote exchanges of researchers and specialists among member States in order to make full use of the technical skills available within the Community.

iii. Technological collaboration in the Economic Community of West African States and the Southern African Development Community

The ECOWAS Treaty includes provisions on science and technology in Article 27, which is based on Article 51 of the AEC treaty. It stipulates the same modes of regional collaboration as the AEC treaty.[43] Similarly, the treaty establishing SADC includes a provision on science and technology cooperation in Article 21, wherein member States agree to cooperate in areas of human resource development and science and technology.[44]

b. Asia

In Asia, the Association of Southeast Asian Nations (ASEAN) is the main regional bloc which strives for closer collaboration in science and technology in various sectors, including industry and energy. Cooperation agreements involve R&D collaboration, technology transfer and exchange of best practices, as well as human resource development.

ASEAN has one of the most extensive cooperation programmes among developing-country regional integration agreements, including technology cooperation in various areas.

i. The Association of Southeast Asian Nations

ASEAN has one of the most extensive cooperation programmes among developing-country regional integration agreements, including technology cooperation in various areas. These programmes involve intraregional as well as interregional cooperation. ASEAN technological collaboration is organized under the ASEAN Committee on Science and Technology (COST). A series of meetings have been held and agreements reached on programmes for technological cooperation. The Fourth Meeting of the ASEAN Ministers for Science and Technology held in Manila on 30-31 January 1989 adopted an ASEAN Plan of Action on Science and Technology and agreed to create an ASEAN Science Fund with seed contributions from member countries.

Based on this, the Framework Agreement on Enhancing ASEAN Economic Cooperation of 1992 includes provisions for technological cooperation in Articles 2 and 3. Article 2 states: "Member States shall enhance cooperation in the field of energy, including energy planning, exchange of information, transfer of technology, research and development, manpower training, conservation an efficiency, and the exploration, production and supply of energy resources". Article 3 states: "Member States agree to increase cooperation in research and development, technology transfer tourism promotion, human resource development and other economic-related areas. Full account shall also be taken of existing ASEAN arrangements in this area."

Since then, ASEAN technological collaboration has been formally recognized in various official agreements that deal with particular aspects of STI, several of which are outlined here. A framework for implementation is loosely incorporated in some of these agreements (box 3.10).

c. Latin America and the Caribbean

The Latin America and Caribbean region has been actively promoting technology transfer for a long time. The Andean Group

Box 3.10: Implementation of technological collaborations within ASEAN

Since the 1992 Agreement on Enhancing ASEAN Economic Cooperation, some of the earlier ASEAN agreements have been amended to enhance collaboration in science and technology in various sectors. These are discussed below.

The Protocol Amending the Agreement on ASEAN Energy Cooperation of 1986 (in 1995) further promotes technological cooperation on energy. It specifies that the range of cooperation will consist of planning, development and human resources development, information exchange, and private sector participation in R&D and technology transfer.[a]

The ASEAN Memorandum of Understanding on ASEAN Cooperation and Joint Approaches in Agriculture and Forest Products Promotion Scheme of 1994 includes industrial technological cooperation in the areas of human resource development, technology development and transfer, and harmonization of standards.[b]

On the issue of IPRs, the ASEAN Framework Agreement on Intellectual Property Cooperation of 1995 (article 1) provides for cooperation on intellectual property as a means to contributing to the promotion of technological innovation and the transfer and dissemination of technology.

In 1996, ASEAN formulated the 2007-2011 ASEAN Plan of Action on Science and Technology (APAST) with a focus on six priority areas: disaster management, biofuels, open source systems, functional food, climate change and health. In December 2010, the Sixth Informal ASEAN Ministerial Meeting on Science and Technology in Krabi, Thailand, endorsed a framework for intraregional cooperation on STI (the Krabi Initiative).

The Hanoi Plan of Action of 1998 (annex III, section II) provides for ASEAN technological cooperation on R&D, including conducting collaborative research, particularly in the areas of "new/improved technologies in food, agriculture and forestry production, post-harvest and processing activities and sharing of research results and available technology". The provision also stipulates the strengthening of programmes in these areas as well as related technology transfer and training.

Source: UNCTAD, based on the various agreements.

[a] *The Agreement on ASEAN Energy Cooperation of 1986 includes a provision on technological cooperation in the development of all forms of energy (renewable and non-renewable) in Article 1, General Provisions, in the Protocol Amending the Agreement on ASEAN Energy Cooperation 1995.*

[b] *Enhancement of Competitiveness of ASEAN Products (section IV), in the Memorandum of Understanding of ASEAN Cooperation and Joint Approaches in Agriculture and Forest Products Promotion Scheme (1994).*

of countries (the Bolivarian Republic of Venezuela, Bolivia, Colombia, Chile, Ecuador and Peru), for example, adopted a common set of policies which were based on the central concept of a common regime for the original six countries on FDI, industrial property and transfer of technology (Articles 30 and 31, Decision 85, May 1974, of the Commission of the Cartagena Agreement). In broad terms, FDI policies favoured investment in sectoral areas considered relevant for the region, particularly those that brought in foreign technologies.

Various other regional agreements, such as those of the Common Market of the South (Mercosur), the Andean Community and the Caribbean Community (CARICOM), contain provisions on technological collaboration. In Mercosur, although there does not seem to be any specific provision for interregional technological cooperation, there are collaborations among individual member countries. There is also triangular development cooperation with the European Union (EU), which is implemented through an official agreement under the Ibero-American Science and Technology for Development Programme, CYTED.

The Cartagena Agreement of the Andean community has a provision for technological cooperation in its Articles 142 and 143 (decision 406 Codification of the Andean Subregional Integration Agreement). There are various regulations that promote technological collaboration, such as on aspects of biodiversity and indigenous knowledge.

The treaty establishing CARICOM also calls for regional technological collaboration. Article 43 of Protocols III and V amending the Treaty establishing the Caribbean Community includes technological collaboration provisions, particularly a stipulation to promote cooperation among member States in R&D, as well as in training, information exchange, human resource mobility, and private sector integration of new technologies.

The Latin America and Caribbean region has been actively promoting technology transfer for a long time.

In 1998, the CARICOM Heads of Government adopted a regional science and technology policy to integrate and harmonize national policies. The Caribbean Council for Science and Technology was designated in 2000 as the agency to coordinate and implement the policy. In addition, a regional policy framework for action was formulated and published in 2007.

3. Interregional cooperation

There are various interregional South-South as well as trilateral development cooperation initiatives.

There are various interregional South-South as well as trilateral development cooperation initiatives, such as the Africa-South America, Asian-African and Afro-Arab cooperation agreements. One example of interregional technological cooperation is the New Asian-African Strategic Partnership of 2006, described below.

a. New Asian-African Strategic Partnership (NAASP)

In April 2005, leaders of Asian and African countries gathered in Jakarta to celebrate the 50th anniversary of the Bandung Conference and identify ways to increase cooperation between the two regions. The joint ministerial statement emerging from this conference called for creating a New Asian-African Strategic Partnership aimed at building a bridge between the two regions. The partnership is intended to cover three broad areas: political solidarity, economic cooperation and socio-cultural relations. The NAASP framework refers to technological cooperation under Section B on Economic Cooperation, which provides for "Fostering research and development and the sharing of relevant technologies, including nanotechnology, biotechnology, and vaccine research".

International organizations such as the United Nations Environment Programme (UNEP), UNIDO, and UNDP often participate in triangular development cooperation projects involving technological collaboration.

b. Programmes of international organizations to support South-South technological collaboration

International organizations such as the United Nations Environment Programme (UNEP), UNIDO, and UNDP often participate in triangular development cooperation projects involving technological collaboration. For instance, UNEP's South-South Cooperation Exchange Mechanism is designed to enhance UNEP's ability to deliver environmental capacity-building and technology support activities in developing countries and regions of the South. UNEP's support to South-South cooperation as part of this initiative is currently being undertaken through the Bali Strategic Plan for Technology Support and Capacity Building.[45]

Another initiative, the UNDP's South-South Global Assets and Technology Exchange (SS-GATE), connects buyers and sellers from countries of the South, enabling them to obtain needed technologies, assets and financing in a secure environment. SS-GATE also aims to provide a platform for exchanging information and experiences for sustainable development centred on technology.[46]

UNIDO has established South-South Cooperation Centres in a few selected developing countries to "contribute to the industrial development and economic growth of developing countries by identifying and mobilizing the technical, financial, managerial, and other resources required for projects and programmes within the framework of South-South cooperation." The project lists the following provisions that are intended to strengthen and facilitate South-South collaboration: exchange of experiences in industrial policy orientation, formulation, and implementation; promotion of institutional and enterprise networking for enhancing productive capacities, trade, technology and investment flows; replication of best practices for poverty reduction through industrial development and grassroots innovations serving as rural growth impulses; strengthening of national and local innovation systems for using modern technologies; enhancing domestic capacity-building and adaptive capabilities to commercialize new knowledge; promotion of regional trade and investments; and promotion of regional integration.[47]

International agencies also play a role in facilitating or supporting the transfer of a wide variety of successful approaches to other developing countries, such as the Lighting

a Billion Lives project discussed earlier on in this chapter. In addition, several international agencies have a large number of technical assistance projects which may also have an impact on technological learning.

E. IMPACTS OF ONGOING ACTIVITIES ON TECHNOLOGY AND INNOVATION CAPACITY

The foregoing sections have provided some examples of ongoing South-South and triangular collaboration in technology and innovation. While the existing literature (e.g. UNDP, 2009; Commonwealth Secretariat, 2011; UNU, 2011) provides more examples of South-South cooperation in general, it is not clear to what extent they deal with technology and innovation or, if they do, what kinds of activities are undertaken. This chapter has sought to fill this gap; while the examples it describes are not exhaustive, they provide a glimpse of the kinds of initiatives that exist in the current context and the drivers of ongoing activities. Some of their impacts are discussed here.

As shown in chapter II, technology and innovation patterns are not independent of ongoing trade and investment patterns of countries, and are often a component within existing relations. The review conducted in this chapter also shows that, while there are a number of instances of ongoing technological collaboration, they focus largely on pharmaceuticals and health, or on RETs, climate change and agriculture. These collaborations are driven to a large extent by government incentives, such as investment incentives (e.g. India-Uganda, and Ethiopia-China collaborations), tax rebates and purchase commitments. The lower level of IPR protection in Uganda has also played a role in the case of the India-Uganda joint venture for the production of ARV and anti-malaria drugs. In renewable energy, the cases discussed show that, in addition to government incentives, market prospects have played a role in the decisions of firms to enter into joint ventures. Indeed, market incentives play an important role in strategic choices of firms generally, as noted in the literature (see, for example, Scott, 1994; DFID, 2009; Lanjouw, 2005). Firms in developing countries also often face more competitive pressure in sectors such as pharmaceuticals and energy, given the technological and financial strengths of firms in developed countries. The former therefore seek to expand their markets through joint ventures abroad. For all these reasons, there is need for greater support for inter-firm collaboration from the governments of all developing countries, particularly those that have the more technologically advanced firms.

These collaborations are driven to a large extent by government incentives.

A second set of issues arises with the growth of ODA from some non-DAC countries. As mentioned earlier in this chapter, five countries – Saudi Arabia, China, the Bolivarian Republic of Venezuela, India and Brazil in that order of magnitude of assistance – accounted for 79 per cent of aid from non-DAC members in 2008 (OECD, 2010). The focus of non-DAC donor countries varies, but on the whole countries such as Brazil, India and Mexico give priority to scientific cooperation in agriculture, pharmaceuticals and health, energy, environmental and industrial development. While governments are focusing increasingly on structuring collaborations in technology and innovation, the extent to which the technical assistance programmes (which focus largely on scientific collaboration) include technological capacity-building is difficult to assess from the data currently available. The regional priorities of countries also vary. Brazil, for instance, focuses in particular on Africa, whereas Mexico has a strong regional focus on other Latin American countries. The expansion of some developing countries' development assistance programmes to African and Asian countries is a recent phenomenon, which is expected to increase in the future. Furthermore, some countries, such as Saudi Arabia, focus much less on technological collaboration in their overall development assistance programmes.[48]

While governments are focusing increasingly on structuring collaborations in technology and innovation...

...the extent to which the technical assistance programmes include technological capacity-building is difficult to assess from the data currently available.

A review of the government initiatives analysed in the last part of this chapter indi-

cates some important results. The first is that, increasingly, emerging countries and other developing countries are considering technology and innovation as priority areas in which to strengthen collaboration with other developing countries and LDCs in the coming years. This greater focus on technology and innovation can be attributed to the ongoing discourse on technology access and capacity-building at the international level, particularly also as part of the North-South discourse. This is a positive development, implying greater public-sector-driven South-South collaboration on technology and innovation. But at the same time, the review of various existing declarations and regional agreements shows the following:

The agreements often contain provisions for greater cooperation in science and technology for various sectors, but implementation tends to be rather limited in depth and scope.

- Only a few agreements refer specifically to South-South collaboration for technological innovation, capacity-building and knowledge accumulation. For instance, these aspects are not referred to in Africa's Consolidated Science and Technology Plan of Action of 2006. A reason for this might be that it is only relatively recently that such areas of South-South collaboration have become a significant option for developing countries.
- The agreements often contain provisions for greater cooperation in science and technology for various sectors, but implementation tends to be rather limited in depth and scope. A case in point is NEPAD (discussed in this chapter), where member countries are calling for greater ownership in this regard. In particular, there is much emphasis on *what* areas require collaboration, but less on *how* this is to be conducted.
- Finally, despite the plethora of government initiatives, there seems to be little coordination between governmental policies and actions by firms in developing countries. All developing countries stand to benefit from such technological collaboration but do not have clear policy linkages to promote the impact of such initiatives on their innovation systems. This is also true of countries in Africa and other regions of the developing world. While there are many regional initiatives on various aspects of science, technology and innovation, it seems that the policy incentives granted by governments in emerging countries and other developing countries are not closely or systematically linked to these broader regional policy visions.

Juxtaposing these results with the broader trends analysed in chapter II of this Report, leads to the conclusion that, although there is significant potential for South-South collaboration in technology and innovation, this is not being harnessed. Rather, current trends seem to point towards a preponderance of technological collaborations within a smaller subset of developing countries. These collaborations are based on a technological give and take as concluded in chapter II, based on the rising technology absorptive capabilities in some of the developing countries. The analysis in this chapter shows that while there is a trend towards greater development assistance and an increasing emphasis on collaboration in technological learning in government pronouncements, greater efforts are needed for implementation. Existing cases of South-South technological collaboration presented in this chapter show that, when designed appropriately, such collaboration can indeed lead to capacity-building in countries. Hence, it is imperative to ensure that such an effort is promoted in a more systematic way through coherent policies.

F. CHAPTER SUMMARY

This chapter has analysed South-South collaboration in technology and innovation in initiatives by both the private and public sectors. It shows that inter-firm technology-related initiatives seem to be fewer and are mainly motivated by economic considerations or express government incentives, or both. Second, public sector and

government-driven collaborations are more wide-ranging in nature, but at the same time they focus more on scientific and technical aspects rather than on technological collaboration or firm-level learning. As the analysis shows, there are several technical assistance initiatives in the widening development support programmes of emerging and other developing countries, but these need to be distinguished from technological collaboration. Nevertheless, these scientific and technical collaborations are very important for strengthening the general skills base of the recipient countries.

There may be scope for newer forms of incentives and a more concerted effort to promote South-South collaboration in technology and innovation in a number of ways. For instance, collaboration could target scientific training and capacity-building in universities and research centres of excellence. In addition, it could promote design and product development activities of the kind that form the backbone of firm-level innovation. This chapter has also presented some major government initiatives in this area that could form the basis of prioritizing policy areas by developing countries, in the process of enacting concrete policies. It finds that many of these initiatives could better serve the needs of developing countries when they clearly stipulate South-South collaboration for technological capacity-building, and are more closely coordinated with governmental policy frameworks and projects within individual countries. The main conclusion that can be drawn from this chapter is that there is a need for a more cohesive policy framework on South-South technology and innovation that ensures that collaboration on technological learning and innovation does indeed become a priority in expanding South-South exchanges.

Despite the plethora of government initiatives, there seems to be little coordination between policies and actions by firms in developing countries.

NOTES

1. This summary is based on Gehl Sampath and Spennemann (2011).
2. This summary is based on Biadgleng et al., (2011).
3. EHGCs form the outer casings used in pills for oral consumption.
4. This section is based on information contained in Thorstendottir et al. (2010).
5. Some other studies report different ODA figures for non-DAC countries. For instance, according to the Commonwealth Secretariat (2011), South-South development cooperation was estimated to be worth $15.3 billion in 2008, accounting for almost 10 per cent of total global development cooperation.
6. Brazil's development cooperation through the ABC has been expanding: between 2005 and 2009, it dispensed a total of $1.7 billion in technical assistance (IPEA et al., 2010).
7. According to ABC (2010), these countries are: Algeria, Angola, Benin, Botswana, Cameroon, Cape Verde, Ghana, Guinea-Bissau, Kenya, Mali, Morocco, Mozambique, Nigeria, São Tomé and Príncipe, Togo and the United Republic of Tanzania.
8. A good example is Brazil's cooperation with Cuba in the health sector, aimed at promoting local capacity in Africa for the treatment of HIV/AIDS, or with Japan in Bolivia, once again focusing on the treatment of HIV/AIDS.
9. See: http://www.embrapa.br/english/.
10. Embrapa opened its African headquarters in Accra, Ghana in 2006 to coordinate all activities with African partners in agricultural development. Further coordinating units of Embrapa now exist in each country where there are ongoing projects.
11. Source: http://www.embrapa.br/a_embrapa/missao_e_atuacao.
12. In accordance with an amendment to Article 1 of the law that created Embrapa which allows the organization to exercise its activities outside Brazil; see: http://www.southsouth.info/profiles/blogs/brazilian-government-to-launch-embrapa-international-by-the-end.
13. In addition to the structuring projects, Brazil has projects throughout Africa that focus on training and agricultural research. These are implemented through bilateral partnership agreements with Angola, Cape Verde, the Democratic Republic of Congo, Ghana, Guinea-Bissau, Nigeria, Togo and the United Republic of Tanzania.
14. Projects are selected through a competitive process and the Platform provides funding of up to $80,000 per project.
15. See: http://portal.fiocruz.br/pt-br/content/estatuto.
16. Fiocruz previously gave priority to technology transfer, and sought to increase its own in-house research and manufacturing capacities through partnerships with the private sector. One example is the strengthening of its vaccine manufacturing capacity (e.g. with GlaxoSmithKline in 1985).
17. It is estimated that about 120,000 Brazilian enterprises contribute financing to SENAI's activities.
18. See: http://itec.mea.gov.in/.
19. Countries include: Argentina; Bangladesh, the Bolivarian Republic of Venezuela, Brazil, China, Colombia, Croatia, Cuba, Egypt, Indonesia, the Islamic Republic of Iran, the Democratic People's Republic of Korea, the Lao People's Democratic Republic, Lebanon, Libya, Malaysia, Mauritius, Mexico, Mongolia, Mozambique, Myanmar, Namibia, Nepal, Oman, Peru, the Philippines, the Republic of Korea, Singapore, South Africa, Sri Lanka, Sudan, the Syrian Arab Republic, Tajikistan, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uzbekistan, Viet Nam, Yemen and Zambia.
20. TCIL, a publicly funded company, is responsible for setting up the necessary infrastructure for the project and for organizing training programmes at the regional centres in Africa in telecoms and in information technology (IT) for paramedical staff designated to operate the equipment/network on a day-to-day basis.
21. The countries are Benin, Burkina Faso, Gabon, Gambia, Ghana, Ethiopia, Mauritius, Nigeria, Rwanda, Senegal and Seychelles.
22. A similar project in Malaysia, the Malay Genome Re-Sequencing, has been initiated with Universiti Teknologi MARA (UiTM) in Selangor.
23. As in India, the Sri Lankan Genome Variation Database has been developed, which is a database of genetic information in the languages of the major ethnic groups. The database currently contains information on genotype frequencies of 34 genomic variations encompassing 14 genes that are considered medically important to Sri Lanka. The database was made accessible to all and it also accepts submissions from the research community. It thus offers researchers and clinicians standardized access to the spectrum of genetic variations in the population.
24. The charging stations are operated and managed by local entrepreneurs trained under the initiative, who rent out the solar lanterns to local rural inhabitants every evening at an affordable cost. This fee-for-service model thus enables the poorest socio-economic groups to gain access to clean energy.
25. Based on information from the Centre of Chinese Studies (2010).
26. Based on UNDP (2009).
27. Mandated by Constitutional Article 89, X, the LCID provides the Government of Mexico with the necessary legal instruments to conduct both, donor and recipient activities related to development cooperation actions and programmes between Mexico and other countries. It also provides for cooperation with international organizations through the exchange of resources, goods and educational, cultural, technical, scientific, economic and financial knowledge and experiences (Art. 1).

28. Mexico's development cooperation gives priority to the following areas: poverty alleviation, disaster prevention, reducing inequality and prevention of social exclusion, promoting education and culture, addressing issues relating to the environment and climate change, science and technology, public safety and health.

29. Two additional components of the Mexican Cooperation system are the International Cooperation Fund (FONCID), which integrates the financial resources for international development cooperation, and the International Cooperation Registry (RECID), which provides all the information, amounts and evaluations of Mexico's international development cooperation projects (SRE-AMEXCID, 2011).

30. Declaration of the Fourth BRICS Summit: BRICS Partnership for Stability, Security and Prosperity, 29 March 2012; available at: http://www.bricsindia.in/.

31. See BRICS Summit, Delhi Declaration, Council for Foreign Relations. Available at: http://www.cfr.org/brazil/brics-summit-delhi-declaration/p27805.

32. The Istanbul Declaration was agreed upon at UN LDC IV, Istanbul, May 2011.

33. The Plan was first formulated at the meeting of agricultural ministers in Moscow on 26 March 2010, and a consensus on its implementation framework was agreed in the first meeting of the BRICS Agricultural Cooperation Working Group in Beijing, China in 2011.

34. See: http://www.ibsa-trilateral.org/index.php?option=com_content&view=article&id=87&Itemid=1.

35. Paragraph 25 of the Brasilia Declaration describes the growing trends since the Buenos Aires Plan of Action (1978), including "the sharing of knowledge and experiences, training, technology transfer, financial and monetary cooperation and in-kind contributions" (see: http://www.itamaraty.gov.br/temas-mais-informacoes/saiba-mais-ibas/documentos-emitidos-pelos-chefes-de-estado-e-de/4th-ibsa-summit-declaration).

36. Paragraphs 20 and 21 of the Brasilia Declaration.

37. http://www.dfa.gov.za/docs/2004/ibsa0305a.htm

38. See: The Istanbul Declaration on the Innovation Network.

39. Istanbul Declaration, UNLDC IV.

40. A concrete outcome of NEPAD's work has been the implementation of the Pharmaceutical Manufacturing Plan for Africa.

41. There are several such programmes. One key AU programme that is progressing is the establishment of a Pan African University (PAU) for Africa composed of five universities across the five regions of Africa (East, West, North, South and Central). The PAU will include the University of Ibadan in Nigeria (covering earth and life sciences), the Jomo Kenyatta University of Agriculture in Kenya (covering STI), a new University in Algiers, Algeria (covering water, energy sciences and climate change), the University of Yaoundé in Cameroon (covering governance, humanities and social sciences) and the university of Stellenbosch, South Africa (covering space sciences).

42. See: Treaty Establishing AEC, Annex III, Article 51, Science and Technology. Available at: At: http://www4.worldbank.org/afr/ssatp/Resources/HTML/legal_review/Annexes/Annexes%20III/Annex%20III-03.pdf

43. Article 27, Science and Technology, in the treaty establishing ECOWAS, Annex III. Available at: http://www.afrimap.org/english/images/treaty/ECOWAS%20Treaty.pdf

44. Article 21 of Treaty Establishing SADC, Annex III. Available at: http://www.iss.co.za/AF/RegOrg/unity_to_union/pdfs/sadc/8SADC_Treaty.pdf

45. This initiative is part of the Bali Action Plan of 2010 of the United Nations Framework Convention on Climate Change (UNFCCC). The Bali Strategic Plan serves as an umbrella framework for "coherent, coordinated and effective delivery of environmental capacity-building and technical support activities" in response to well-defined country priorities and needs". See: http://www.unep.org/south-south-cooperation/unepssc/history.aspx.

46. UNDP's South-South Global Assets and Technology Exchange (SS-GATE) platform available at: ssgate.ssc.undp.org.

47. See: http://www.unido.org/index.php?id=4915.

48. Saudi Arabia spends 20 per cent of its ODA on education that falls under scientific cooperation (see for example, OECD, 2010).

4

HOW CAN THE SOUTH PROVIDE A NEW IMPETUS FOR BUILDING INNOVATIVE CAPACITY?

CHAPTER IV

HOW CAN THE SOUTH PROVIDE A NEW IMPETUS FOR BUILDING INNOVATIVE CAPACITY?

A. INTRODUCTION

The key insights gained from the preceding chapters can be summarized as follows. First, the South has become a major exporter of technology-intensive capital goods to various developing countries. However, at present, South-South trade relationships are dominated by countries that have the capacity to absorb and participate in the creation of new technological products and processes.[1] As a result, most of these transactions occur between emerging countries themselves, and are determined by the ability of partners to engage in a quid pro quo process of collaboration. That is to say, technological collaboration despite being an intrinsic part of these transactions is of a kind where the partners undertake an exchange of their relatively different skills and knowledge to enhance their competitive base.

Second, there is some level of technological collaboration between developing countries that feeds into technological learning processes and helps to build innovation capacity. As chapters II and III have shown, these exchanges have been contributing in various ways to building innovation capabilities in the developing world. However, a large number of developing countries, particularly LDCs, are currently excluded from most South-South technological exchanges because they lack the necessary absorptive capabilities that would enable them to participate in such exchanges.

Third, trends analysed in chapter II of this Report show that ongoing South-South cooperation could potentially provide greater opportunities for developing countries and LDCs to benefit technologically. For example, the analysis on FDI shows that, despite its current regional concentration, South-South FDI could be more versatile in combining with capability-building approaches. Examples presented in chapter III also show that firms from developing countries seeking to expand into newer markets could be significant partners for FDI that promotes skills development and the acquisition of tacit know-how. The rising share of FDI from developing countries into sectors such as services also creates opportunities for technological collaboration in these sectors.[2]

Fourth, as shown in chapter III, there are quite a few interesting cases of scientific and technical collaboration, both public-sector-based and private-sector-led, but these do not seem to demonstrate the full potential of South-South collaboration for technological learning and innovation. It could be argued that since South-South technological collaboration is still in its initial phase, there is a lack of coordinated efforts. However, given the growing importance of technology and innovation in the global landscape and the need to explore all significant means of promoting technological change in developing countries, it seems appropriate to address the key challenge.

How is it possible to ensure that the emphasis in government initiatives and platforms on South-South collaboration on technology and innovation results in greater technological learning? Ensuring this calls for measures that promote closer linkages

How can we to ensure that the emphasis in government initiatives and platforms on South-South collaboration on technology and innovation results in greater technological learning?

between government agenda-setting and ongoing scientific and technological collaboration as well as inter-firm technological alliances.

Is it possible to leverage the ongoing catch-up processes taking place in some of the developing countries to...

Many of the pertinent issues in the emerging landscape of South-South technological exchange are similar to those that stand out in the debates on North-South technological exchange. To begin with, limited technological capabilities in some countries cause them to be marginalized in both South-South and international trade. Those countries that have a fair level of technological capabilities are able to make better use of trading opportunities to export and further differentiate their export baskets through technological upgrading opportunities in both South-South and international exchanges. On the other hand, specific patterns of global demand have resulted in the further entrenchment of many developing countries in sectors where possibilities for technological specialization are limited.

These patterns of global demand do not automatically lead to technological upgrading of the kind that is conducive to structural change and overall economic development. This is particularly observable in the case of LDCs in the international trading system (see, for example, UNCTAD, 2010a). Requirements imposed by the international trading system exacerbate these effects through the overall loss of policy space, tariff measures, and the use of protection measures (UNCTAD, 2002; 2006b). This mutually damaging interface between trade and technology needs to be addressed urgently.

...facilitate learning and capacity-building in the other countries?

How can the South be a true partner in efforts to promote innovation and technological learning in developing countries? Is it possible to leverage the ongoing catch-up processes taking place in some of the developing countries to facilitate learning and capacity-building in the other countries? In some ways, these questions lead to the more general questions being explored by the literature on economic convergence and the flying geese hypothesis and their applicability to developing countries. But in other ways, these questions are more nuanced and are focused on technological development and the growing technological divide.

This Report argues that developing countries are potentially strong partners in efforts to promote technological learning in other developing countries for two important reasons. The first reason is perhaps the most pronounced in the discourse on why and how South-South technology and innovation should be promoted. The emerging countries and their innovation experiences are highly relevant for other developing countries as they face similar innovation constraints, which are in many ways different from the constraints and opportunities of developed countries. While developed countries continue to emphasize mainly R&D and IPR protection for their firms, in developing countries the main emphasis has been on technological learning, incremental innovation, learning-by-doing and reverse engineering. The second reason is that developing countries' technologies may be particularly appropriate for building capabilities in the South (a point discussed in detail later in this chapter).

As a result, collaboration on technology and innovation is perhaps one of the most critical components of South-South solidarity, offering a real promise of sustainable development across the South. However, because South-South collaboration in innovation and technology takes place between developing countries at very different levels of development, it will necessarily involve some pressures as well as opportunities for many developing countries. Pressures include conforming to the requirements imposed by the international trading system as well as the challenge of ensuring that developing countries pursue a path of economic growth that is inclusive and sustainable. As chapter I has noted, many developing countries, including emerging countries, have economic sectors that still require particular attention, in addition to the pressing needs of poverty alleviation and employment creation.

While South-South trade offers a good opportunity for developing countries to use their technological strengths to gain market advantages in the developing world, it is not automatic that activities that tap into such advantages would be able to focus in parallel on technological learning. Indeed, as chapter I has noted, often there may be frictions between enabling greater market access to developing-country firms , on the one hand, and using this as the basis for promoting technological learning and technology transfer. Therefore, in order to deliver on its promise, South-South collaboration on technology also needs to factor in the requirements of developing countries, particularly LDCs for building their domestic technological capabilities. That is, it is necessary to define the terms on which such collaboration can be promoted *with particular attention* to the technological needs of individual developing countries.

In order to ensure a true partnership among developing countries for technological development and to exploit the unique advantages of such a partnership, there is need for an international framework aimed at harnessing the opportunities provided by ongoing South-South technological exchanges. Such a framework should actively promote South-South collaboration for building technological capabilities. However, its proponents should not place a disproportionate onus on emerging countries; their collaboration should be seen as a complement to – and not a substitute for – North-South collaboration on technology issues.

Such a framework for South-South collaboration on technology and innovation needs to move beyond mere priority setting and political declarations; it should propose a clear road map for action. This chapter articulates a set of principles that could form the basis for such an international framework. These principles are derived from some important issues prevailing in the context of technology and innovation exchange globally and among developing countries. How can the technology needs of developing countries best be accommodated as a priority in South-South technological collaboration? This seems to be a fundamental issue in analyses of ongoing South-South technological collaboration using all the relevant data available. Another issue is how best to ensure the sharing of experiences for promoting technological learning and innovation capacity. Third, how can important channels of technological learning, particularly the promotion of technological alliances and the means of technology transfer, be harnessed for the benefit of all developing countries? Fourth, how can South-South FDI be more development-oriented? Finally, how can South-South innovation and technological collaboration be leveraged to drive R&D in critical areas that respond to the particular needs of developing countries, particularly where market incentives for the promotion of R&D by the private sector are absent?

In this sense, there is a need for new thinking on how to identify and promote opportunities for South-South innovation and technological collaboration in the areas of climate change adaptation, renewable energy technologies, ICTs and public health, among others. This chapter discusses these issues in detail, along with possible policy options to implement them. Sections B to F contain an elaboration of the five principles, and section G proposes the policy measures to implement them.

While South-South trade offers a good opportunity for developing countries to use their technological strengths to gain market advantages in the developing world…

… it is not automatic that activities that tap into such advantages would be able to focus in parallel on technological learning.

B. PRINCIPLE 1: INTEGRATING THE TECHNOLOGICAL NEEDS OF DEVELOPING COUNTRIES INTO SOUTH-SOUTH EXCHANGES

Debates on the knowledge economy stress the importance of knowledge as an asset for economic activity. “Knowledge of knowledge”, that is, information on where knowledge is available, in which forms, and how it can be applied to further a firm’s or a country’s competitive advantage, is a key

economic resource (Roberts, 2009). However, developing countries cannot automatically seize opportunities to participate in the knowledge economy or benefit from its effects. Most often countries that do not have the technological capabilities to benefit from the knowledge economy find themselves excluded. Closing the gap between formal and informal production structures in a large number of developing countries, particularly LDCs, and promoting domestic capabilities calls for more proactive engagement in addressing their technological needs in a coherent and dynamic manner.

This form of engagement not only necessitates greater investments in tertiary education, skills training and competence-building within countries; it also needs to be reinforced through greater access to knowledge and technological capacity-building through, for example, inter-firm collaboration, joint ventures and licensing agreements. Support for knowledge-based activities in developing countries and LDCs is therefore essential for transforming their economies from ones dominated by activities with decreasing or constant returns to those with a focus on greater value added and higher returns.

Addressing the technological needs of all developing countries is therefore important from a broader perspective of economic development.

1. Building absorptive capacities to tap into South-South trade and global production networks

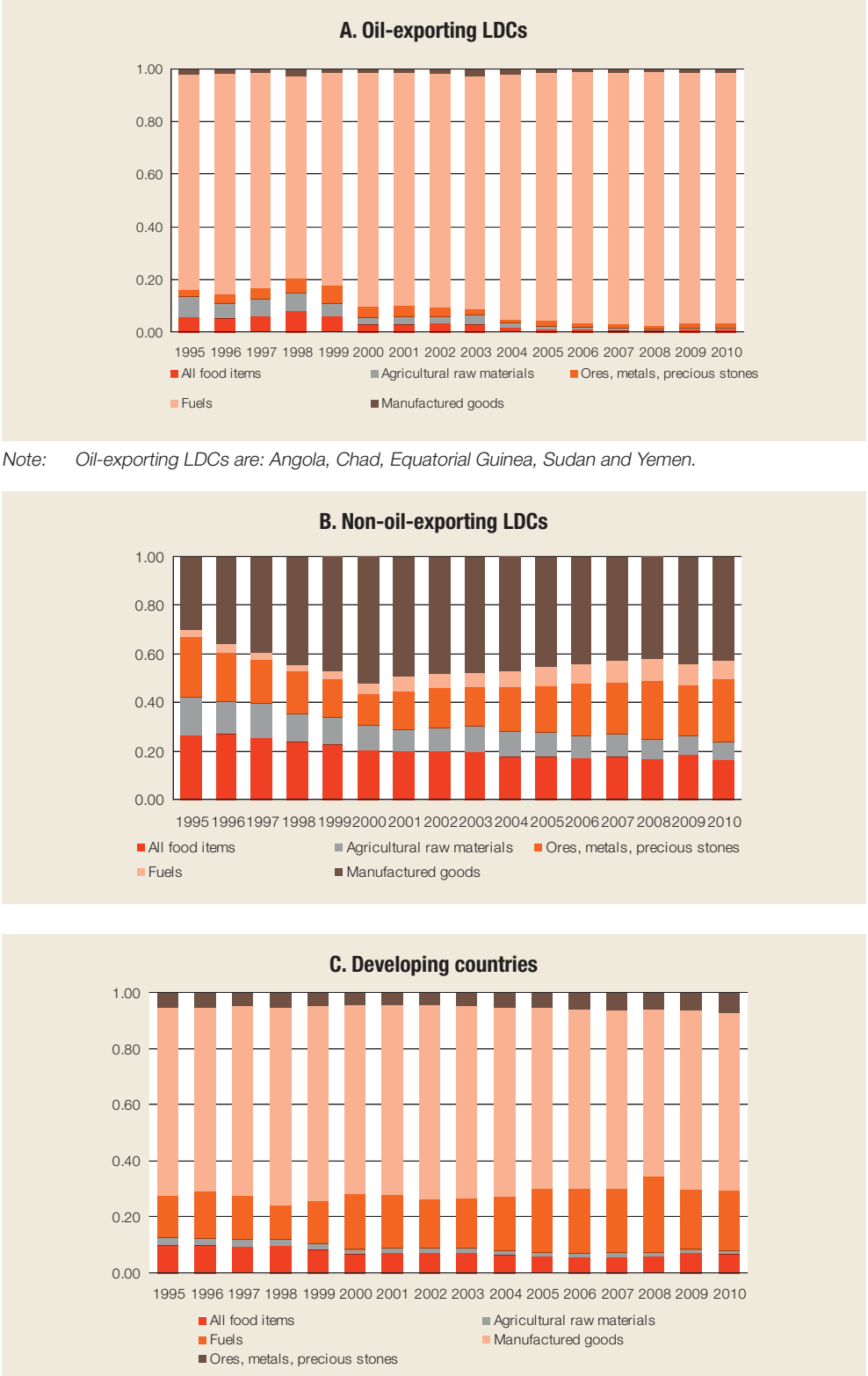
Technology embedded in machinery and equipment has long been considered an important source of new technology for countries.[3] When local agents have the absorptive capacities to use the embedded technological knowledge in a variety of ways to produce local products, learning and capabilities are gradually fostered. However, it cannot simply be assumed that local actors have the necessary absorptive capabilities. Indeed, the absence of such capabilities is one of the major impediments to promoting technological change in developing countries.

As the analysis in chapter II of this Report shows, current South-South technological collaboration is occurring mainly among the more technologically advanced developing countries. LDCs and other developing countries are limited by their inability to partake of these opportunities. In a large number of these countries, the demand for capital goods imports for productive sectors is low due to the constraints they face in manufacturing. Figure 4.1 contrasts the composition of merchandise exports between oil-exporting LDCs, non-oil-exporting LDCs and all developing countries to compare the levels of structural diversification of their economic activities. The figure also helps to show ongoing technological downgrading in the LDCs over time (see also UNCTAD, 2010a and 2011b). Imports and exports are similar indicators of technological capabilities, in the sense that an increase in exports of manufactures indicates a rise in the overall technological capabilities of a country. When a country's sectoral activities are diversified and productive, imports of capital goods provide technological information that feeds into ongoing processes of technological learning.

A comparison of the merchandise exports of developing countries with those of LDCs – both oil and non-oil exporters – shows much larger variations in exports of manufactured goods compared with primary exports. The share of manufactured exports also varies between oil-exporting and non-oil-exporting LDCs, showing the low levels of structural diversification in the former economies. Addressing the technological needs of these countries is therefore important from a broader perspective of economic development, because innovation capacity and technological learning contribute not only to export competitiveness and local enterprise development; they are also critical for promoting diversification of the kind that contributes to structural change.

The lack of technological absorptive capacities of many of these countries also limits their ability to participate in GPNs. Participation in such networks demands high degrees of competence all along the supply chain. At the same time it enhances the ability of local firms in developing coun-

Figure 4.1: Composition of merchandise exports of oil-exporting LDCs, non-oil- exporting LDCs and developing countries, 1995–2010 (Per cent)



Note: Oil-exporting LDCs are: Angola, Chad, Equatorial Guinea, Sudan and Yemen.

Source: UNCTAD secretariat, based on GlobStat – Merchandise Trade Matrix, Exports and Annual 1995–2010.

tries to coordinate various inputs in the innovation process, such as infrastructure and skills.[4] The trends discussed in chapter II have resulted in the opening up of newer opportunities for participation in GPNs across a wide variety of sectors among developing countries. Given the important role being played by GPNs as an integrating force in the global economy, the challenge is to enhance capabilities and opportunities in other developing countries and LDCs in order to promote innovation-led development in their economies. Ensuring that all developing countries and LDCs are able to tap into existing and emerging opportunities in trade and GPNs will require more active engagement in promoting learning and building capabilities. This also calls for addressing both external and internal constraints in these contexts.

Given the important role being played by GPNs as an integrating force in the global economy…

2. Targeting internal and external constraints on building capabilities

A number of developing countries and LDCs experience common constraints on innovation, depending on their stage of development. The extent of these constraints and the difficulties in promoting policy and institutional reforms explain why a large number of developing countries and LDCs are unable to foster innovation capabilities. The constraints can be internal and external, and the former are constantly reinforced by a large number of external factors. Internal constraints include intrinsic limitations faced by local agents, such as the absence of requisite skills, weak institutional infrastructure, lack of research capacity, inadequate financing and risk-sharing mechanisms, and a lack of (or poor) physical infrastructure (box 4.1). These factors impede the capacity of local agents in firms, universities and research institutions to absorb technological information and apply it to routine learning-by-doing activities, which are the backbone of innovation capacity-building. Developing countries, particularly LDCs, are also subject to other external "agents of restraint" through the multilateral trade regime and as a result of commitments to IPR protection under the TRIPS Agreement (Storm, 2005; UNCTAD, 2010a). Their inability to take advantage of technological opportunities is further constrained by current patterns of integration of countries into global commodity markets, which lock in developing economies, particularly LDCs, at the lower end of international value chains.

. …the challenge is to enhance capabilities and opportunities in other developing countries and LDCs in order to promote innovation-led development.

a. Internal constraints on building capabilities

There are some major limitations to building capabilities and engaging in technical change in developing countries and LDCs, which can be categorized under four broad headings, as discussed below. This Report calls for South-South technological collaboration to be more actively engaged in addressing these limitations.

i. Inadequate investments in technological learning

Learning opportunities for innovation arise regularly from a variety of sources, such as from investments in new machinery and equipment, technology suppliers, mobility of labour, interactions with other knowledge agents (e.g. other firms, formal R&D units within enterprises, State-sponsored R&D institutions and university centres of excellence and business associations). External opportunities, such as contract manufacturing for exports and for supplying to global value chains, are additional sources of learning. However, learning does not occur automatically or without costs; it requires appropriate policies and institutions. For many countries, the opportunities for industrial learning have been rather limited due to inadequacies in the institutional framework for innovation, particularly those related to physical and knowledge infrastructure, and to the lack of incentives to engage in a collective learning process with others.

One important element enabling firms in developing countries to integrate into the global market is their ability to produce to established international standards. A critical enabler in this respect is the levels and kinds of skills of employees. Employees

Box 4.1: Technological learning and national systems of innovation

Technological learning, as established in theory and practice, is the process through which firms and organizations in developing countries build capabilities.[a] It is made possible through the accumulation of knowledge and skills that allow firms to learn and build the requisite capabilities to acquire, assimilate, use, adapt, change and create new and useful innovations. Furthermore, building capabilities is a much broader concept than capacity-building, and requires both scientific and non-scientific kinds of infrastructure, linkages and institutional mechanisms that promote interactive learning.

However, there is an important difference between using existing knowledge in production processes (technological capabilities) and the ability to modify and change that knowledge according to new demanding situations (innovation capability). In order to succeed in the unpredictably changing modern environment, firms should be able to use their knowledge and skills, but also, most importantly, they should be able to adapt, rearrange and modify their knowledge constantly and dynamically in response to changing and evolving conditions, situations and demands (Bell and Pavitt, 1995; Patel and Pavitt, 1997 and 1998). Accumulation of knowledge that leads to technological and innovation capabilities is not automatically generated by the use of production inputs. It requires explicit efforts aimed at promoting technological learning within national contexts. The linkages between these two processes are neither as automatic nor as straightforward as they may seem.

Such knowledge and skills can be fostered and built from within a country/sector, through targeted investments in what are termed "national systems of innovation". Simply put, a national system of innovation comprises all economic and non-economic actors that are involved in interactive learning for the production of new products/processes/organizational forms. Interactive learning and improved coordination is the essence of technological learning in the innovation system. It therefore involves investment for building knowledge (including investment in education and skills development, as well as R&D) and for improving physical infrastructure (such as roads, internet and communication technologies, electricity and other inputs to the production process). It also requires institutional mechanisms for creating linkages and for coordination. Local skills and know-how can be nurtured through access to knowledge and technology from outside the sector/economy in order to develop innovation capacity. Technical change that results from this process is largely incremental, as is innovation capacity itself, but it is also very useful in helping to build capabilities and advancing productivity growth.

Source: UNCTAD.

[a] *See Lall, 1992; Ernst et al., 1998; and Bell and Pavitt 1992, for early classifications, and more recently, Sagasti, 2004 and Oyelaran-Oyeyinka and Gehl Sampath, 2010, for an account of the main functions that boost technological capabilities.*

participate in the learning process in a firm, though the most common sources of formal skill creation are universities and technical schools that provide scientific and technical knowledge. In many countries, demand for a better educated and skilled workforce has increased as a consequence of technological changes, such as the introduction of ICTs (see, for instance, Autor, Katz and Krueger, 1998; Howell and Wolff, 1993). A more skilled workforce is more capable of learning complex technologies (Piva, Santarelli and Vivarelli, 2003).

Often, training is used as a complementary mechanism in firms and organizations to impart specific knowledge or to make up for the shortfalls (or often the lack of a practical orientation) in university education. However, training should not be considered a substitute for the formation of basic skills and knowledge of the workforce; it is simply a means through which a firm enables its employees to acquire knowledge specific to that firm's needs. In the long term, in order to be able to constantly upgrade, it is important that the skills and knowledge taught at universities and training centres be of a higher level than those already mastered by those employed in industry. But not many developing countries have been able to provide educational courses and curricula that meet the growing demand for a skilled workforce. This impedes their ability to assimilate knowledge from existing sources.

ii. Weak support to local enterprises

Much of the literature on entrepreneurship in developing countries focuses on the "missing middle", namely the weak development of small and medium-sized enterprises (SMEs) in the formal sector, particularly medium-sized domestic firms (UNCTAD, 2006b). Informal microenterprises, which use basic traditional technologies and cater to small local markets, account for

a large share of the entrepreneurial activities in LDCs. In addition to the focus on SMEs, however, there is need for a renewed interest in larger firms and in factors contributing to the expansion and growth of SMEs, both in policy and practice. Not only do larger firms innovate more than smaller firms, they are also able to take advantage of the economies of scope and scale required for competitive production in several sectors of utmost importance both locally and for exports, such as agro-processing and pharmaceuticals. However, innovation systems in developing countries have several limitations that impede the transition of informal enterprises into SMEs, as well as the transition of SMEs into larger firms that are capable of taking on the risks inherent in process and product innovations. Such limitations include, but are not limited to, the lack of or inadequate financing of innovation and standards, insufficient means to aggregate and pool demand, design and engineering services, as well as poor or insufficient management, marketing and legal expertise.

Institutions are essential at each stage of the innovation process.

iii. Weak institutional linkages

There is an overwhelming agreement on the central role of institutions in promoting innovative capacity within a given system. Institutions are essential at each stage of the innovation process: to grant incentives to actors to innovate and collaborate at the individual level, to enable knowledge flows and interactive learning between the different components of the innovation system at the organizational level, and to establish a link between knowledge and its dissemination in the form of production outputs at the systemic level.

Without such support, access to knowledge remains, at best, access to information, since the actors lack the capacity to build further upon it.

Recognizing the importance of institutional and policy frameworks, governments across the developing world are involved in setting priorities for technology and innovation to respond to the needs of their population and stimulate economic growth. As opposed to a more traditional approach to science and technology, the past decade has seen a sweeping shift towards science, technology and innovation policies, with a greater emphasis on how investments and endowments in science can be used to build technology and innovation capacity. A range of developing countries and LDCs have new innovation policies – or are in the process of adopting them – which seek to address the constraints on innovation in developing-country contexts. Efforts to use the flexibilities in the global IPR regime and targeted policy measures to address public concerns relating to health and agriculture, for instance, are also on the rise. However, devising and monitoring these policies is extremely challenging: considerable knowledge and skills are required for their enactment and for designing long-term strategies for innovation.[5]

iv. Inadequate domestic resources to create a supportive environment for innovation

Interactive learning is a major component of innovation. It ensures that the skilled workforce within any innovation system is constantly benefiting from collaboration with other knowledge sources, both internal and external, for the production of new products and processes. To support policy initiatives, adequate financial resources are needed for the creation of the necessary skills, the provision of good infrastructure (such as laboratories and centres of excellence) and the promotion of collaboration (including through financial incentives). Without such support, *access to knowledge remains, at best, access to information*, since the actors lack the capacity to build further upon it. However many developing countries lack the necessary funds to enable this process. In addition, a lack of risk-taking also explains why there is a conspicuous absence of enterprises – even small enterprises – engaged in innovation. Many of the firms and organizations in developing countries have to rely primarily on public sector institutions to play a dynamic role as catalysts of learning and technological upgrading. Mobilizing domestic resources is therefore a critical task, without which any policy initiatives for creating a suitable environment for innovation are constrained in their ability to produce positive outcomes.

b. External constraints on learning and building capabilities

Other constraints, external to national innovation systems, often tend to reinforce internal limitations of countries in promoting innovation, or in some cases they even exacerbate them. It is clear by now that structural transformation is achieved by means of upgrading production and exports, industrializing and thereby diversifying economic activities. The patterns of specialization developed by countries are idiosyncratic in nature: their export choices are determined not only by factor endowments (as classical theory dictates), but also by external trading opportunities and global demand, and by internal technological capabilities of sectors and firms.[6]

Some specialization patterns that usually depend on export opportunities are more conducive to technological upgrading than others. When combined with the right forms of public investment and policy support, they can lead to productivity- enhancing structural change. But current patterns of global integration are such that the more knowledge-intensive product niches are concentrated in a few developing countries and in the industrialized countries, and the low value-added and primary-commodity-based exports are concentrated in LDCs and in several other developing countries with lower technological capacities.

These patterns of specialization tend to reinforce ongoing production patterns by entrenching a large number of developing countries and LDCs in natural-resource-based and low-technology exports and some medium-technology exports. Excluding the examples of developing countries such as China and India and some East and South-East Asian countries, growth trends in many developing countries and almost all the LDCs over the past decade have been accompanied by few, if any, changes in their productive structures, as demonstrated by figure 4.1 (see also, UNCTAD, 2007, 2008 and 2010a).

Other external constraints include the global IPR regime, which poses difficulties for developing countries in leveraging technology transfer, as discussed later in this chapter.

C. PRINCIPLE 2: SHARING EXPERIENCES IN BUILDING INNOVATION CAPABILITIES THROUGH PROACTIVE POLICIES

The ways in which manufacturing firms in developed and developing countries build their technological capabilities differ. In the technology-intensive sectors, developed-country firms, regardless of their size, build their core strategic capabilities at the international technological frontier (Dosi, 1988; Dosi and Marengo, 1993; Nelson and Winter 1982; Teece, Pisano and Shuen, 1997; Teece et al.,1994). Technological intensity is a key element of market competitiveness, and IPRs serve as strategic assets for firms' alliances and expansion. Firms in emerging countries and in much of the developing world have faced obstacles in accessing knowledge, and have relied on other ways to build the essential knowledge base necessary to survive in the market. Many channels of knowledge diffusion among firms in the South have been the same as those observed in the North, such as technical collaboration between firms, equipment procurement, joint ventures, cross patenting, M&As and licensing (WIPO, 2011; OECD, 2011). At the same time, firms in emerging countries have built their own technological competencies in the face of constraints on innovation, which in most ways are similar to those faced by other developing countries, particularly LDCs today.

Emerging countries have pursued a variety of industrial and development policies and strategies to promote technological catch-up.

Emerging countries have pursued a variety of industrial and development policies and strategies to promote technological catch-up. Innovation policies can be understood as purposive actions and incentives provided by governments to promote interactive learning and collaboration among all economic and non-economic actors in the sys-

tem. Such policies have been instrumental in overcoming market imperfections that obstruct technological change, and which are pervasive and widespread, particularly in developing countries (Rodrik, 2007).

1. General policy insights from country-level experiences

A review of the development discourse and lessons learnt from state-led East Asian successes in the 1980s and the 1990s (Amsden, 1989; Woo-Cummings, 1999; Stiglitz et al, 2012), and, more recently, the experiences of countries such as Brazil, China and India have identified a number of factors critical to their process of technological catch-up. Broadly, the following factors have been identified as being critical to this process:

- Establishment of public research and technical education institutes.
- Acquisition of scientific and technological knowledge through collaboration with foreign research institutions, foreign firms or joint ventures, or through the acquisition of foreign firms.
- Diffusion among domestic firms of knowledge acquired through collaborations with foreign firms to reduce technological dependence on foreign firms.
- Provision of financial and fiscal incentives to support local firms' R&D activities, and the adoption of policies requiring foreign firms to invest more in local production in developing countries.

Modality of technology accumulation has varied from sector to sector in accordance with the specific needs of the country concerned.

Catch-up experiences of countries suggests that the process of acquisition of technological knowledge through the aforementioned mechanisms generally has been conducted through North-South relations (Amsden, 1989; Woo-Cummings, 1999; Oyelaran-Oyeyinka and Gehl Sampath, 2010; Cimoli et al., 2010; Stiglitz et al., 2012). It further suggests that the modality of technology accumulation has varied from sector to sector in accordance with the specific needs of the country concerned.

The establishment of education institutions for research and technology was particularly significant for developing domestic capabilities to accumulate and adapt the technological knowledge acquired through collaborations with foreign institutions. The provision of government incentives for R&D, improved financing possibilities and increased domestic demand induced through supportive government policies also played a central role. However, in addition to these factors, a range of more nuanced policies come to light from the experiences of these countries, which have been equally – if not more – critical to promoting their innovation capacity and catch-up processes. A large number of their policies were prompted by the need to reduce the adverse impact of external constraints and impediments to learning by local firms or organizations. These are discussed in the next section.

2. Specific policy strategies and policy linkages to promote innovation-led growth

Specific policies and policy linkages of relevance gleaned from the experiences of the now emerging countries and even from those of today's industrialized countries (derived from economic history, such as Mansfield, 1985 and Chang, 2002) help to identify the following relevant factors. The role of the State in promoting technological learning, conceptualizing appropriate technologies for technological catch-up, IPRs and flexibilities and their implications for economic catch-up, and finally, the linking of innovation policies to broader industrial policy have served as elements of well-eked out policy strategies for innovation-led growth.

a. The role of the State in promoting technological learning

Developing countries can learn many important lessons for technological development from the experiences of the State-led industrialization strategies of the NIEs of East Asia (Stiglitz et al., 2012; Oyelaran-Oyeyinka and Gehl Sampath, 2010). One

of these lessons relates to the role of the State, which is critical for articulating innovation choices, promoting the acquisition of finance for technological activities through domestic and external resource mobilization, and for reducing risks inherent in the innovation process. Despite being constrained in numerous ways, the State can play a vital role in pooling together national economic, social and industrial resources to bring about change. Given its ability to coordinate at every level of governance, it can also be instrumental in recognizing new technological opportunities, promoting the requisite entrepreneurship and distributing the gains from innovation in an equitable manner. In particular, a well-charted government strategy for innovation that meets social as well as local demands is critical in terms of giving direction to other actors in the innovation system on where to focus their activities.

b. Appropriate technologies for technological catch-up

The term "appropriate technology" has varying connotations in the discourse on the technological development of developing countries. There exists an extensive body of literature on the concept of appropriate technology based on analytical arguments relating to development strategies for developing countries. For instance, many studies suggest particular criteria for defining and determining appropriate technologies (e.g. Wicklein, 1998; Grundy, 1991; Scheraga, Tellis and Tucker, 2000). In brief, appropriate technologies, according to these definitions, would have the following characteristics:

- The technology transferred should function without elaborate supporting devices or infrastructure and must fit within an existing system in the recipient country;
- The technology in question should not patronize; rather, it should promote the recipients' economic interests and effectiveness;
- If the technology is system-dependent, it should match the available system parameters of the recipient;
- The technology transferred must be locally affordable in its entirety;
- The technology should be appropriate and adaptable to the recipient's environment;
- The transferred technology must possess characteristics that allow its further development; and
- The transferred technology should be capable of being applied in varied ways so that it can be suitably propagated.

These characteristics of appropriateness emerged at a time when policymakers and academics were trying to grapple with what technological exchange and transfer entailed. The inability of the recipients of certain technologies to effectively use, apply and adapt them in local contexts led to a wider notion that only those technologies that could be "absorbed" by the recipient system were appropriate. While some of these characteristics remain valid, there is a need to reconsider what the notion of "appropriateness" means in the context of South-South technology and innovation exchange. Any technologies are appropriate in the context of development so long as technological exchange or transfer is not limited to simply providing only the technology or information related to its use; it should also involve the active transfer of know-how.

Another notion on South-South technological development that has been floated suggests that the most appropriate technologies are those that help to address pressing issues of public importance, such as health, agriculture or climate change. Without prejudice to these sectors, however, such pre-selection may not be very productive or conducive to developing innovation capacity in recipient countries. Countries' limited abilities to absorb technologies, due to such factors as the lack of skills and resources for innovation, tend to be generic and systemic, and will therefore apply to all sectors in an economy. Indeed, developing absorptive capacity is central to promoting learning. Another important

Despite being constrained in numerous ways, the State can play a vital role in pooling together national economic, social and industrial resources to bring about change.

Any technologies are appropriate in the context of development…

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policy issue that stands out from earlier experiences is that structural diversification is a process of distributing skills upgrading and innovation capacity across various sectors of the economy, and that industrial development is holistic in nature. It derives from a cohesive environment that supports investment, innovation and technological learning, and export competitiveness. It is therefore important to eliminate sectoral biases which may be inimical to the process of promoting technological capabilities, and instead build as broad a technological learning base as possible.

While a growing share of local patents, as opposed to foreign-owned is evidence of growing technological prowess…

A second important lesson learnt that is relevant in this context is that many technologies are interdependent in ways that cannot be predicted ex-ante. For example, competencies such as those gained in biotechnology can be equally applied to agriculture, pharmaceutical or chemical industries, among others. The same is true for other technologies such as ICTs, which are applicable to a range of sectoral activities. These factors challenge the notion that learning in developing countries, particularly LDCs, should be prioritized and that some sectors should assume precedence over others when discussing technologies that are needed as a priority. Predetermining technological priorities should be left to individual countries in their policy-setting.

c. IPRs, flexibilities and learning options

Several studies on the impacts of IPRs and the factors that underlie decisions of countries to opt for IPR protection have led to similar conclusions (Scotchmer, 1991; Maskus and Reichman, 2005). Individual choices of countries are likely to be prompted more by the motive to cement the advantages of their firms, especially in the high-tech sectors, internationally or regionally, and this invariably results in harmonized regimes that reflect high levels of IPR protection (Hall and Ziedonis, 2001; Lanjouw and Cockburn, 2000). This trend is also increasingly observed among emerging countries. For example, over the past decade there has been a marked rise in the patenting of technologies for climate change mitigation in countries such as China and India (UNCTAD, 2011c). While a growing share of local patents, as opposed to foreign-owned, in emerging countries is evidence of their growing technological prowess, it raises certain pertinent issues for technological access and change in other developing countries and LDCs.

…it raises certain pertinent issues for technological access and change in other developing countries and LDCs.

From a historical perspective, there are several important ways in which economies such as, Japan, the Republic of Korea, Taiwan Province of China and the United States have taken advantage of technological knowledge from outside in their development processes by tailor-making their respective IPR regimes. The experiences of these countries paved the way for experimentation in a variety of developing countries (including China and India). During their development phase, these countries provided only a minimum of IPR protection (Maskus, 2004). Japan's patent system, for instance, was designed to facilitate innovation and diffusion (Ordover, 1991). It provided for utility patents, permitted only single claims in a patent application and required pre-grant disclosure. The system also instilled an active patent opposition regime and encouraged incremental and adaptive innovation. In addition, Japan strongly encouraged innovative foreign firms to license their technologies to Japanese firms. The country's Ministry of Trade and Industry (MITI) was actively involved in the technology licensing process by examining the terms of technology licensing contracts (Maskus, 2000 and 2004; and box 4.2). Furthermore, importantly, Japan's experience shows a high degree of coordination between its IPR regime and other aspects of its innovation policy framework.

Similar IPR strategies have been employed by other economies, such as the Republic of Korea and Taiwan Province of China (box 4.3), to promote innovation, either by not granting IPRs or by granting a particular variant of IPR protection, such as the adoption of utility models. The importance of these experiences is supported by the fact that more recently a number of developing countries and LDCs have been considering similar strategies.

Box 4.2: Tailoring IPR regimes to local developmental needs: the case of Japan

In Japan, the IPR system was construed as part of a broader innovation system. The Government encouraged local firms to assimilate imported technologies through all means, including FDI. This led to improvements in the overall system of innovation (see, for example, Freeman, 1987; and Nelson, 1993), in particular, in the ability of Japanese firms to design products and processes. The "quality circles" created by the innovation policy were promoted by an emphasis on social innovation that was designed to maximize the contribution of the lower levels of the workforce and to assign responsibility for technical change to lower management levels. The Government adopted an "integration strategy" which brought together the best available resources from universities, government research institutions and private and public industries to solve the most important design and development problems (Peck and Goto, 1981).

To support its innovation strategy, Japan reformed the education and training system. As a result, the rate of enrollment, especially in science and technology (S&T), increased steeply. In S&T education, industrial training of the kind relevant for firms was emphasized with the aim of building all-round capabilities, including at lower levels of the workforce. This enabled a more rapid handling of equipment breakdowns and maintenance, and ensured a smoother assimilation and more ready acceptance of new process technologies (Gregory, 1985). Further, the Japanese system of "decentralized management" permitted greater horizontal integration, and technological improvements in design, development and production (Aoki, 1986). Technology-related forecasting was carried out to determine which technologies should receive greater focus. This orchestration of strategy was achieved by a combination of central government coordination (mainly by MITI) and by the initiatives of Japan's large industrial conglomerates (*keiretsu*).[a]

Source: UNCTAD.

[a] *Japan revised its patent regime between 1988 and 1993 to make it compliant with the Paris Convention.*

Continuing policy initiatives in emerging countries, particularly China and India, also provide examples of potential ways to use existing flexibilities in the TRIPS Agreement. [7] Such cases carry lessons for LDCs which are in the process of gradually implementing the TRIPS Agreement. UNCTAD, for instance, has argued for the use of incremental innovation patents, based on the model adopted by the Republic of Korea, for use in countries such as Uganda (UNCTAD, 2009b). Pursuing such possibilities offer several opportunities for developing countries in particular sectors.

The pharmaceutical sector has been one such sector, wherein the Doha Declaration on the TRIPS Agreement and Public Health allowed until 2005 for developing countries to comply with that Agreement's patenting provisions relating to pharmaceuticals. In the pharmaceutical sector, in particular,

Box 4.3: Utility models implemented in the Republic of Korea and Taiwan Province of China

Given that a large number of LDCs are obliged to provide IPR protection, the search for flexible options that also promote industrial development is on the rise. In this context, the models used in the Republic of Korea and Taiwan Province of China can offer some useful options.

In both these economies, a limited amount of IPR protection, often in the form of a utility model, was used as a policy incentive to encourage local firms to invest scarce capital in reverse engineering for technological learning. The utility model is a weaker form of IPR protection as it has a lower requirement of inventive steps or novelty, but it is usually granted for only a few years. This model was also used by Japan and the first-tier NIEs (Kumar, 2002).[a]

In the Republic of Korea, the smaller, but smart, local firms were encouraged to reverse engineer technical knowledge embodied in products that was readily available through foreign suppliers to these firms (Kim, 2002). In Taiwan Province of China, firms were similarly encouraged to upgrade after the 1986 patent reforms which allowed three kinds of patent protection: inventions, new utilities and new designs (Hu and Mathews, 2005). In sectors where such protection was prevalent, firms/individuals were allowed to patent the technical proficiency of their products without actually allowing any claims on the underlying ideas/processes.[b]

Source: UNCTAD, based on Gehl Sampath (2010).

[a] *However, the utility model of IPR protection in these countries was very different from that observed in many developed countries such as Germany (Gehl Sampath, 2010).*

[b] *Ideas alone are not patentable, except in connection with a product or process. In pharmaceuticals, countries such as India (until 2005) and the Republic of Korea granted patents only on processes, not products. Competitors could thus reverse engineer an unprotected product and make it through a different, unprotected process.*

the requirement that developing countries such as India should comply with the TRIPS Agreement relating to pharmaceutical product and process patents has caused concern about whether these countries will be able to continue to develop and produce more affordable generic versions of drugs that are important for treating diseases that are prevalent in other developing countries and LDCs. Given the large price differentials between pharmaceutical drugs developed by Indian and other developing-country firms and developed-country firms, governments in some LDCs have sought to promote local production capabilities in the health and pharmaceuticals sectors in recent years. Many of these countries are exempt from the obligation to offer patent protection on pharmaceutical products as required by the TRIPS Agreement until 2016, and could therefore offer a base for manufacturing generic versions of drugs that are patent-protected in certain non-LDC countries. However, as LDCs face numerous problems in establishing viable local production facilities that meet quality standards, they need to build technological capabilities in this sector.

Continuing policy initiatives in emerging countries provide examples of potential ways to use existing flexibilities in the TRIPS Agreement.

The building of such capabilities is being supported by several international and bilateral agencies, such as the WHO, the European Commission (EC), UNIDO and UNCTAD. South-South technological collaborations are also an essential means for building those capabilities, as illustrated by two case studies discussed below. These case studies are presented in chapter III, but their salient features with respect to IPRs and other institutional parameters are described here.

i. India-Uganda collaboration: Quality Chemicals (Uganda) and Cipla Pharmaceuticals (India)

This is an archetypical example of how technology and related tacit know-how have been transferred from an emerging-country firm to a joint venture in an LDC. The Government of Uganda actively supported the creation of the joint venture between a local company, Quality Chemicals Industries, with a major developing-country manufacturer of generic drugs, Cipla Pharmaceuticals, for the sustainable production in Uganda of high-quality, low-cost ARVs and anti-malaria drugs to supply the East African region. The Government of Uganda offered specific incentives to encourage Cipla to choose a local firm in Uganda including free land, investment and a buy-back guarantee for products produced in the plant up to seven years (see chapter III for details). From an IPR perspective, the policy document of the Ugandan Government clearly states the need to build local production capacity in the country, given the threat to supplies of cheap reliable generic drugs from developing-country firms due to the deadline of 2005 contained in the TRIPS Agreement for all developing countries. This IPR issue played a role in the decision of Cipla Pharmaceuticals to participate in the joint venture (Gehl Sampath and Spennemann, 2011).

ii. Technological collaboration in Bangladesh's pharmaceutical sector

Bangladesh, with the assistance of Indian and other foreign producers, has established itself as a major manufacturer and exporter of pharmaceutical formulations since the 1980s. It is now seeking to take advantage of its LDC status to manufacture active pharmaceutical ingredients for drugs such as antibiotics. It offers a good example of how LDC firms can thrive in this complex sector by concentrating their businesses on key inputs along the pharmaceutical production process. Local pharmaceutical firms dominate the production landscape with a wide range of generics that include antiulcerants, flouroquinolones, antirheumatic non-steroid drugs, non-narcotic analgesics, antihistamines, and oral antidiabetic drugs. As an LDC, Bangladesh, like Uganda, is exempted from implementing the pharmaceutical patenting provisions of the TRIPS Agreement until 2016. As a result, its domestic pharmaceutical companies are benefiting

extensively and trying to build joint ventures and alliances with foreign firms, especially those from China, India and some East Asian countries to improve their product quality and standards.

d. Linking innovation policies to broader industrial policy

To address market imperfections that hamper innovation and industrial development, countries in East Asia and Latin America have employed industrial policies extensively in their catching up processes as a means to removing obstacles to structural transformation. Industrial policies have typically aimed at providing a range of incentives for industrial transformation and development (O'Connor and Kjollerstroem, 2008; Stiglitz, Sen and Fitoussi, 2010; Cimoli et al., 2009). Successful components include those that target the expansion of capital- and knowledge-intensive sectors through associated technological learning, promote the generation of forward and backward linkages, boost demand, and help create competitive advantages (UNCTAD, 2011c). Policy instruments relating to technology and innovation are therefore a key component of industrial policy in countries. Several subcomponents of technology and innovation policies, such as those relating to FDI and IPRs, can be fine-tuned to promote technology flows and technology transfer through the broader industrial policy framework.

The gains from IPR policies in terms of technology transfer also depend on the industrial policy of the IPR granting country. TNCs may engage in FDI, joint ventures or licensing, depending on the broader objectives set out in the innovation and industrial policy frameworks of the host countries. In addition, to ensure more significant technological spillovers, forward and backward linkages need to be established for which industrial policy can play an important role (boxes 4.4 and 4.5).[8]

D. PRINCIPLE 3: PROMOTING LEARNING THROUGH ALLIANCES AND TECHNOLOGY TRANSFER

Policy instruments relating to technology and innovation are a key component of industrial policy in countries.

A critical shift in South-South collaboration on technology and innovation is needed, with a focus on promoting technological learning based on the South's own rich and diverse experiences, as highlighted in this chapter. Some of the means of such learning, such as technology transfer, have been demanded by developing countries in the international discourse for decades (Patel et al., 2001; Maskus, 2004). Technological development implies more than just promoting the import of technologies through FDI and TNC activities or through trade in capital goods. As mentioned above, what

Box 4.4: Industrial policy and IPRs: China's experience

In recent years, China has provided an example of how to use industrial policy to gain from establishing linkages between IPRs and technology transfer. A study conducted by the United States International Trade Commission (USITC, 2011) observed that China's policy to promote indigenous innovation includes six crucial provisions to promote local innovation: (i) every year, the Government prepares a catalogue of indigenous innovations, and the products listed therein get preference in procurement by both the central and provincial governments to encourage Chinese firms to develop and manufacture products embodying new technologies; (ii) China has introduced its own technical standards that differ from international standards. Such standards encourage local adaptation of foreign technology as well as Chinese made products; (iii) there exists a strong anti-monopoly law; (iv) Chinese firms are entitled to tax benefits if R&D is undertaken within China and if the IPRs on such products/processes are locally owned; (v) in a number of high-tech industries, including aviation and automotives, foreign firms' access to the Chinese market has often been contingent on the requirement that they transfer specified technology to a Chinese firm, generally a joint-venture partner; and (vi) some firms investing in China are subject to a local content requirement in order to create backward linkages.

As a result of such policy support for Chinese firms to encourage indigenous innovation, the share of Chinese resident patents as a percentage of total patents granted in the country has been steadily growing.

Source: UNCTAD, based on USITC (2011).

is more crucial is the building of capabilities through skills development and the transfer of operation and maintenance know-how which promotes technological progress.

Mechanisms for technological collaboration have traditionally focused on a North-South dimension, but there are also opportunities to develop South-South mechanisms for sharing of experiences on technological capacity-building and transfer. Indeed, these could be more appropriate in the developing-country context, given that these countries share common development challenges. Such mechanisms could complement ongoing efforts to foster North-South technology transfer by placing an explicit emphasis on technological learning and building local capacities for innovation. One such mechanism is the creation of strategic technological alliances between some developing countries, particularly between the emerging countries with LDCs or with other developing countries, to promote learning in sectors that already have some level of domestic technological capabilities. Technology transfer and the sharing of tacit know-how is another instrument that the South could use to pioneer different solutions by leading by example.

There are also opportunities to develop South-South mechanisms for sharing of experiences on technological capacity-building and transfer.

1. Promoting strategic alliances for overall technological growth

The proliferation of inter-firm alliances has raised expectations of accelerated long-term growth opportunities for developing countries by enabling faster access to markets and advanced technologies and offering greater learning possibilities.[9] However, evidence shows that, although developing-country firms have increased their participation significantly, recorded formal alliances are still overwhelmingly concentrated among developed-country firms. A small group of rapidly developing countries with significant capabilities and large domestic

Box 4.5: Use of policy instruments to promote technological alliances in East Asia

The Republic of Korea, Singapore and Taiwan Province of China have successfully leveraged alliances to develop their technological capabilities and dramatically expand their GDP over the past several decades. In each of these economies, the government strategy has been threefold: (i) link domestic firms to the global economy in order to build indigenous skills and technological capabilities; (ii) leverage relationships with other countries and TNCs to establish meaningful connections of strategic value; and (iii) learn as much as possible about international best practices and state-of-the-art technologies, then build on these foundations and improve on them.

The approaches adopted by the governments of each of these economies, have varied for achieving these objectives and for developing technological capabilities, as highlighted below.

Taiwan Province of China	Republic of Korea	Singapore
Strategy: development of a national technology and innovation system focused on building the country's export-oriented SMEs. • Established an investment promotion agency for identifying suitable industries and technologies, also through technlogical alliances. • Established a science and technology institute for acquisition, reverse engineering and diffusion. • Created a marketing agency aimed at providing exporting firms with relevant information on foreign markets. • Created an agency to support clustering to link larger firms to clusters of smaller firms.	Strategy: promotion of large indigenous national firms that could quickly learn from and compete with developed-country TNCs. • Introduced policy measures to ensure that FDI, licensing agreements and technology exchange hastened the building of technological capabilities at the enterprise level. • Created an institutional framework that allowed the Government to allocate performance-based incentives, such as subsidized credit, to a small number of entities that eventually became large conglomerates.	Strategy: promotion of linkages between indigenous SMEs and the global value chains of TNCs, including through technlogical alliances. • Provided an incentive system and institutional framework to attract TNCs. • Created investment promotion agencies that sought investments from foreign firms and industries. • Created agencies responsible for industrial estates. • Established export-processing zones. • Established licensed manufacturing warehouses.

Source: UNCTAD, based on UNIDO (2006:37-38).

markets seems to have benefited much more than others. Primarily, TNCs operating in developing countries have utilized cross-border partnering and networking to significantly raise those countries' technological capabilities and business competitiveness. Significant activity has also been recorded in natural resource exploration and exploitation. These ongoing developments offer lessons for all developing countries on how to leverage technological alliances to develop technological capabilities (see box 4.5).

More recently, other developing countries, particularly China and India, have been using technological alliances to build local capabilities. Although many of these are not strictly South-South, they help to show the importance of such alliances and how they could be applied in the South-South context to build technological capacity. The Indus Towers joint venture is an outstanding example of how two Indian telecommunications companies entered into a strategic partnership with a foreign company to reduce passive infrastructure costs and further strengthen their technological capacity (box 4.6).

Technological alliances do not necessarily have to be firm-driven. Alliances can significantly expand opportunities for companies interested in accessing markets and technologies and for governments interested in indigenous capacity-building and economic growth. However, benefits do not flow automatically; nor do partners necessarily gain equally. There is considerable learning associated with setting up and managing successful alliances, and policy decisions can help facilitate them. Furthermore, governments can promote those alliances which would enable developing countries and LDCs to leverage their potential for technological capacity-building.

Alliances can significantly expand opportunities for governments interested in indigenous capacity-building and economic growth.

2. Technology transfer and developing countries

Debates in international and regional policy arenas since the 1960s have not managed to reach much consensus on core aspects of technology transfer and how it can be fa-

Box 4.6: The Indus Towers joint venture

A recent example of a successful joint venture in the telecoms industry is that of the Indian tower management company, Indus Towers. Indus Towers was established in November 2007 as a joint venture involving Bharti Airtel, Idea Cellular (Indian companies) and Vodafone Essar (a United Kingdom company) with the aim of reducing passive infrastructure costs for each company.

Over the past decade, the Indian telecoms industry has been undergoing extraordinary growth, with some experts forecasting an 80 per cent penetration rate by as early as 2017. Early competition in this industry was intense and marginal revenues were very low compared with other countries, which posed challenges for capital investment in new tower infrastructure. At the beginning of 2007, only 25 per cent of wireless towers in India were shared by telecoms operators – a system that was inefficient for operators because firms were building towers in overlapping areas that could easily have been serviced by a single tower.

Bharti Airtel and Vodafone Essar, the two largest private telecom service providers in India, realized they could cooperate on tower development while remaining competitive in their core businesses of providing telecom services. They therefore decided to jointly establish an independent firm to construct and manage towers throughout the two firms' common operating areas. Idea Cellular, the third largest telecoms operator in India, was also offered a smaller share in the new firm, which it accepted based on the expansion prospects this could provide.

Negotiating and implementing the terms of the joint venture posed several challenges for the parties involved. Determining how to value the assets that each company contributed was an early source of friction, which was resolved through the establishment of a point system whereby the towers were rated based on attributes such as location and size. The companies then contributed capital for erecting new towers such that the point values were equal among each partner. Other early issues included network downtime, the lack of a standardized data-sharing platform, and conflicts between the strategic objectives of the participating companies. Indus Towers was able to resolve these challenges in large part due to equal representation on the management board and a shared understanding of the issues to be resolved.

Over the years, Indus Towers has grown into an efficient vehicle that operates towers throughout the country, and has successfully evolved into an independent tower company. Today, it is the largest telecom tower company in the world, with a portfolio of over 110,000 towers, and it plans to add 5,000 more towers annually until 2015.

Source: UNCTAD, based on Gulati et al (2010).

cilitated. Developing countries have repeatedly stressed the need for a new technology transfer paradigm with better indicators designed to promote and measure technology transfer, especially since the current global IPR regime has the tendency to reinforce existing technological advantages (UNCTAD, 2010a, and 2011b and c). Issues relating to technology transfer are currently being debated in several international forums, including in the WTO in the context of discussions on Article 66(2) of the TRIPS Agreement, which calls on WTO members to promote the transfer of technology to LDCs, and in the World Intellectual Property Organization (WIPO) in the context of the WIPO Development Agenda (box 4.7).

Issues relating to technology transfer have also been discussed extensively in the context of specific technologies, particularly those relating to public health and innovation in the WHO Commission on Intellectual Property Rights, Innovation and Public Health (CIPIH) and to climate change mitigation under the United Nations Framework Convention on Climate Change (UNFCCC), as part of the Technology Mechanism (TM). Of all these various discussions, those relating to the TM have been the most effective. The TM is an agreed instrument that seeks to promote technology transfer with the intent of building national innovation capacity and technological learning.[10]

As a complement to ongoing discussions, and to lead the way in forging productive solutions, the South could play a key role in demonstrating constructive means to achieving technology transfer. These would entail structuring government-driven technological alliances that seek to promote greater technological learning with a clear impact on innovation capacity. They should include all forms of activities, including scientific cooperation to build educational institutions and human skills, technical cooperation to enhance the capacity to enact and coordinate policies, and technological collaboration that entails the exchange of tacit know-how and design capabilities at the firm level. Furthermore, since innovation capacity is wider than technological skills, South-South technological collaboration should also promote learning in a broader, comprehensive sense. This is further discussed in chapter V of this Report.

Many developing countries are already engaged in some areas of cooperation of this kind. For example, as chapter III shows,

Box 4.7: Major international debates on technology transfer

Article 66(2) of the TRIPS Agreement: There is a longstanding debate about the extent to which the technology transfer obligation contained in Article 66(2) of the TRIPS Agreement has been honoured. In particular, there has been very little empirical analysis on whether and to what extent this provision has resulted in a greater transfer of technologies to LDCs. Moreover, very few reviews exist that examine whether Article 66(2) has resulted in an increase in technology flows between developed countries and LDCs (Moon, 2008 and 2011). A study based on country self-reports to the TRIPS Council between 1999 and 2007, and focusing mainly on the public policies and programmes that developed countries have undertaken to encourage their organizations/enterprises to engage in such technology transfer arrived at two important conclusions (Moon, 2008). It found that a lack of definitional clarity on key terms such as "technology transfer" and "developed country" made it difficult to determine which WTO members were obligated to provide incentives, of what kinds and towards what ends. It noted that many countries did not submit reports to the Council on a regular basis, but that out of the 292 programmes and policies reported, only 31 per cent specifically targeted LDC members of the WTO. Of these, approximately a third did not actually promote technology transfer. Thus, out of the 292 programmes, only 22 per cent involved technology transfer specifically targeted to LDC members of the WTO.

WIPO Development Agenda: Cluster C of the WIPO Agenda and the recommendation therein deal with Technology Transfer, Information and ICTs and Access to Knowledge. Recommendation 28 calls for policies and measures to promote the transfer and dissemination of technology to developing countries. As part of this cluster, a Project on IPRs and Technology Transfer (CDIP/4/7), submitted for approval at the fifth CDIP session for a third time and was approved for implementation. The previous submissions had failed to be approved owing to a lack of consensus on how technology transfer should be defined and what it entails.

Source: UNCTAD, based on Gehl Sampath and Roffe (2012).

several governments, such as those of Brazil and India, are engaged in significant scientific and technological collaboration. By furthering existing efforts in such collaboration within a more coherent framework, developing countries could help to show the way ahead in international discussions on technology transfer.

E. PRINCIPLE 4: MAKING DEVELOPING-COUNTRY FDI MORE TECHNOLOGY ORIENTED

Many countries have leveraged FDI to promote technological dissemination and innovation capacity. The Republic of Korea provides an example of a country that has sought FDI as a source of technology within its overall industrial development strategy (box 4.8). There are instances where South-South FDI has had positive results in terms of building national technological capabilities. Interesting examples of how governments have promoted the transfer of tacit know-how by the foreign investing firm to the local partner are those of Uganda and Ethiopia discussed in chapter III.

FDI can be combined with a variety of other policy measures, as demonstrated by the case of the Republic of Korea earlier, and more recently by the experiences of Uganda and Ethiopia (chapter III). The disjunction between innovation policies and FDI policies in countries is of particular note. This disjunction needs to be addressed through an innovation policy that allows recipient countries to realize the potential of FDI for technological learning.

F. PRINCIPLE 5: POOLING RESOURCES OF DEVELOPING COUNTRIES TO ADDRESS COMMON TECHNOLOGICAL CHALLENGES

Where there are insufficient firm-level capabilities to support the creation of conventional forms of technological alliances, or where new alliances for particular kinds of technologies are of critical importance to the developing world, there is a need for innovative mechanisms for knowledge production and dissemination. Areas of particular interest for addressing social needs include technological innovations

The disjunction between innovation policies and FDI policies in countries is of particular note.

Box 4.8: FDI and the catch-up process in the Republic of Korea

The experience of Republic of Korea illustrates the importance of domestic policy in seeking out FDI to boost the catching up process. Original equipment manufacturing (OEM) was a specific form of subcontracting that evolved out of the joint operations of TNC buyers and NIE suppliers. Under OEM, finished products are manufactured according to the specifications of the TNC which then markets the products under its own brand name. In the Republic of Korea, OEM accounted for a significant share of electronics exports during the period 1970–1990.

Initially, OEM partners helped in the selection of capital equipment and the training of managers, engineers and technicians, and offered advice on production, financing and management. As a result of this collaboration, Samsung (Republic of Korea) began making electronics in 1969 jointly with Sanyo (Japan). In 1981, Toshiba (Japan) licensed microwave oven technology to Samsung. In 1982, Philips (the Netherlands) supplied Samsung with colour television technology, and videocassette recorder technology was licensed from JVC and Sony (Japan) in 1983. By 1992, one in five microwave ovens sold in the United States was made by Samsung, mostly under OEM with the firm General Telephone and Electronics Corporation (GTE, an American company). Later Samsung placed greater emphasis on sales of its own brands, which increased to 55 per cent in 1992, to 56 per cent in 1993 and to 57 per cent in 1994.

By the 1980s, major companies from the Republic of Korea had become lead producers and exporters of technology-intensive goods. Japanese firms such as Matsushita, Sanyo and NCE withdrew from joint ventures as tax advantages were cancelled and firms were encouraged by the Government of the Republic of Korea to leave. Around the same time, networks (*chaebols*) created with the help of Koreans returning from abroad became dominant sources of new knowledge for production and exports.

Source: UNCTAD.

for promoting a green economy, including for climate change mitigation and adaptation, sustainable energy and the greater use of renewable energy technologies, as well as for public health and food security. Even within these areas, currently the sharing of knowledge has not been systematic. Instead, there is a continued reliance on North-South exchanges in finding technological solutions.

This Report suggests the pooling of technological resources by developing countries through a comprehensive South-South Innovation and Technology Pact (SITEP).

As mentioned earlier, developing countries' experiences in building innovation capacity tend to be more relevant for bridging the technological divide. Moreover, their technologies are also often more locally adaptable in other developing countries and LDCs owing to similar contexts, and hence they are more appropriate for those countries. The South faces many common constraints internationally, such as the challenges of mitigating climate change, ensuring industrial growth in a green economy, and promoting food security and access to medicines, for which common responses could be forged.

In order to facilitate a common, developmental response to these issues, this Report suggests the pooling of technological resources by developing countries through a comprehensive South-South Innovation and Technology Pact (SITEP). The proposed Pact, as envisaged here, would be an international mechanism that seeks to coordinate and promote a developing-country response to technological issues. The SITEP would provide institutional support at three levels. To begin with, it could promote technological learning at the firm level as an essential complement to ongoing South-South scientific cooperation and technical assistance programmes (chapter III). At a second level, the SITEP could also promote enterprise development and the financing of specific innovation activities that are of particular importance to developing countries. Finally, the Pact could act as a platform for sharing innovation experiences and promoting learning at the policy-making level.

Policy options to implement these principles are needed in all developing countries.

G. LEVERAGING THE SOUTH FOR TECHNOLOGY AND INNOVATION: POLICY INCENTIVES AND ACTIONS

This section proposes policy options to implement the principles elaborated in the previous sections of the chapter. These policy options are not exhaustive – they are merely intended to help show the way forward. Moreover, they should not be construed as binding developing countries, particularly emerging economies, to exacting technological commitments. Rather, they are intended to facilitate the development of an international framework on South-South technological collaboration aimed at promoting the mutual interests of all developing countries, both as suppliers and recipients of technological knowledge in collaborative ventures.

Policy measures that could help implement two of the principles identified earlier, namely fostering absorptive capacity in developing countries and making developing-country FDI more development-oriented, are discussed first. This is followed by a description of policy incentives for promoting learning and technology transfer. Finally, a policy instrument is proposed that could help forge common innovation responses by all developing countries.

1. Fostering absorptive capacity through South-South collaboration

Learning of the kind that builds absorptive capacity is multifaceted: it includes technological learning along with other kinds of learning, such as that related to business processes, marketing and finance, all of which contribute to promoting innovative capabilities. In all this, the State has an indispensable role to play by articulating a policy vision for learning and innovation capacity-building. Ideally, such a vision should be accompanied by an innovation policy that promotes the building of domestic capabilities (box 4.9).

A large number of developing countries and LDCs have an overarching innovation policy framework. It may not specifically be designated as such, but a myriad of policies that amount to an innovation policy do exist. However, such policies are not sufficient to identify and prioritize technology needs in a strategic manner. Designing and implementing innovation policies in developing countries are therefore a starting point for prioritizing the technological development of these countries. This Report suggests that a proactive innovation policy that clearly identifies technological needs is a prerequisite for promoting innovation capacity systematically within developing countries, taking advantage of new sources of such capacity-building, such as NIEs and other developing countries.[11]

Such innovation policies, along with technological needs assessments, could be accompanied by the following policy measures specifically aimed at encouraging South-South collaboration in technology and innovation.

Given the newly emerging opportunities for South-South technological learning and exchange...

...innovation policies at the national and regional levels need to be revised.

a. Coordinating local and regional innovation policies with South-South collaboration initiatives

As noted in chapter II, there is often a disjunction between national and regional policies on technology and innovation. Furthermore, given the newly emerging opportunities for South-South technological learning and exchange, many existing policy instruments do not expressly refer to South-South collaboration in this area. The new reality needs to be recognized by revising innovation policies at the national and regional levels in order to incorporate certain key innovation priorities in South-South

Box 4.9: National innovation policy frameworks

Incentives provided by national innovation policies target a broad range of learning activities. The competence to enact and match different policy instruments is key to enhancing the performance of sectors that are technology-intensive and promote value added.

Horizontal policies are usually directed at stimulating innovation capacity across the system as a whole, without targeting any specific sector or industry. These include policies aimed at building the necessary knowledge and physical infrastructure, and promoting collaboration and interlinkages:

i. *Policies aimed at building a knowledge infrastructure* include those relating to investments in training and education and R&D (e.g. government funding of research), government procurement of technology-intensive goods and standards setting.

ii. *Policies to improve physical infrastructure* include those relating to investments in, for example, roads and highways, and provision of good water and energy facilities as well as ICT facilities. Energy is part of the critical infrastructure without which industrial development is not possible.

iii. *Policies that promote collaboration* are central to interactive learning. Collaboration can take different forms depending on the actors involved in innovation within national systems. They include, in particular, interactions between:

- Suppliers and producers (e.g. university-industry programmes)
- Users and producers (for the articulation of demand)
- Producers and other producers (at the firm level)
- Users, producers and suppliers (e.g. organizations such as technology research organizations generally acting as a bridge between scientific organizations and industries)
- Support organizations for business firms (including government agencies)

In addition to such horizontal innovation policies, depending on the sectoral and other priorities set by the national innovation policy, a range of targeted policies can be adopted to support innovation. Broadly, these may be classified into two functional areas: incentives for the commercialization of university research, and incentives that reduce the financial risk inherent in innovation. To promote commercialization of university research, specific incentives could include the granting of IPRs to universities, geographical clustering policies that locate biotech clusters around institutions of scientific learning, technology foundations and biotechnology exploitation platforms. Policy measures that promote financing of innovation include seed-financing programmes, enterprise subsidy programmes (for setting up new biotechnology start-ups, for example) and common placement funds for innovation and tax credits for research.

Source: UNCTAD.

relations. A range of policy measures could be implemented that expressly promote South-South technological collaboration. They could include, for example:

- Linking developing-country FDI with clearly identified requirements for technology and tacit know-how;
- Providing/using existing government funding to promote scientific and technical collaborations between developing countries in priority sectors (in the same region or even other regions);
- Granting special incentives and tax reductions to local firms for entering into or attracting joint ventures or joint production arrangements with firms from developing countries, with a particular focus on acquiring technologies;
- Providing special tax cuts and other advantages to foreign firms from developing countries, particularly emerging countries, including assurances of government procurement in return for setting up production facilities and transferring know-how to local firms;
- Providing technological incubation facilities to support new technology ventures in local industry with the help of firms from other developing countries, particularly emerging countries.

Innovation funds, both at the national and sectoral levels, could help to promote such a shift towards value-added goods and services.

b. Providing specific incentives to encourage a shift towards greater value added activities

In order to minimize the risk of local firms remaining at the lower ends of GPNs, with few or no chances of moving up the value-added stages of production, there is a need for explicit policy measures that support engagement in manufacturing value-added activities, which are essential for structural transformation. Policy measures could also target value-added social activities, whereby the development of innovation capacity focuses on catering to local needs and also promotes equitable and inclusive development.

Emerging countries could adopt policy measures that would help to increase the focus on mutually beneficial collaborations in technology and innovation.

Innovation funds, both at the national and sectoral levels, could help to promote such a shift towards value-added goods and services. In countries that are particularly rich in natural resource endowments, innovation funds could be created to catalyse an explicit policy shift towards value-added activities. A good example is Chile, where the Government has allocated a certain proportion of its total revenues from natural resources to an innovation fund that provides incentives for enterprises and research institutions in economic sectors of national importance. There are other countries where sectoral innovation funds have been created to alleviate innovation constraints (box 4.10).

In a broader context of South-South and regional development, such funds (with some institutional variations) could also be created at a regional level to facilitate the development of overall innovation capacity. A case in point is the Mexico-Chile Fund, operated jointly by the two countries for development cooperation in the region (see chapter III, box 3.8).

c. Policy incentives in emerging countries for a greater technological focus

In order to ensure that technological learning is an essential component in South-South interactions, emerging countries could adopt policy measures that would help to increase the focus on mutually beneficial collaborations in technology and innovation. These could take the following forms: policies that promote long-term engagement with other developing countries; those that aim at a better coordination of technological collaboration activities by their firms and organizations with scientific and technical cooperation agencies; and the provision of incentives to national firms to engage in technology exchange and the building of tacit know-how with firms in other developing countries.

i. Adopt policies that promote a long-term technological orientation

The overall technological development of the South is a strategic goal that will have

Box 4.10: Innovation funds in Brazil and Chile

Brazil's Sectoral Funds for Science and Technology were established in 1999 to leverage industry-based revenues for R&D in select sectors. The Funds' key objective has been to provide more stable financial resources for STI activities in the country. They are expected to support firms' technological efforts, including their R&D expenditures, and increase their number of technical-scientific employees as well as their levels of productivity and/or exports. Ultimately, the aim is to generate positive externalities for the society as a whole.

The Funds are financed by income generated in 12 industrial sectors, primarily through levies on enterprise turnover in the industries that were privatized in the 1990s, including energy and telecommunications. The introduction of these sector-specific levies was intended as a means of preserving innovation intensity after privatization, given that the former State-owned enterprises that had formerly dominated the network industries were active R&D investors.[a] The Sectoral Funds' strategic collective management approach ensures a clear and transparent process and promotes collaboration.

Chile has been in a process of prioritizing the country's innovation activities since the beginning of the 2000s. The Chilean Government has taken a series of steps, including reforming its innovation policy and the setting up of the National Innovation Council for Competitiveness (OECD, 2007). It is recognized that major impediments to innovation in Chile are a shortage of skills, a lack of entrepreneurial culture, low R&D expenditure[b] and a concentration of almost half of public research in the capital city, Santiago. These factors are seen as hindering efforts to diversify the economy through a shift towards value-added activities.

In an effort to overcome some of these impediments, the Government created the Innovation Fund for Competiveness (Fondo de Innovación para la Competitividad (FIC)) in 2006. The FIC is an instrument for channelling financial resources accruing from royalties from the mining sector to finance implementation of its innovation policy. These financial resources are channelled into medium- and long-term financing of innovations identified as priorities for the country (OECD-IDB, 2010).

The Chilean fund is an attractive model which could be applied by several natural-resource-rich developing countries and LDCs for building their domestic innovation capacity.

Source: UNCTAD.

[a] *Other sources of finance for the Sectoral Funds are the earmarking of revenue and a 10 per cent levy on payments to non-residents for technical assistance and royalties. The composition of revenue sources varies across the sectoral funds.*

[b] *The 2007 OECD Innovation Review and the 2009 OECD Territorial Review of Chile both estimate the R&D expenditure of Chile to be 0.7 per cent of its GDP.*

positive network effects for all developing countries. This needs to be reflected in the long-term visions and policy strategies of all developing countries, particularly emerging countries, with clear targets and milestones set for achieving technological collaboration, including firm-level, firm-organization and public-private partnerships. These will be aimed at national firms, which, more often than not, will be the more technologically advanced partners in collaborations, such as TNCs from developing countries or core firms of GPNs based in emerging countries. Currently, a long-term vision exists in some commercial and economic transactions, but it needs to be expanded to include technological collaborations based on a long-term perspective.

ii. Adopt policies that link technical and scientific cooperation with technological collaboration

Technical and scientific cooperation builds the scientific base and skills of actors in any innovation system. These skills are then employed to access technology, and to use and apply the technology for the generation of new and innovative products. Currently, as chapter III shows, although many developing countries are actively engaged in expanding their scientific and technical assistance activities, there is a lack of coordination between the scientific and technical cooperation provided by their agencies and the ongoing technological collaborations between firms. These activities should be better coordinated by means of a clear policy on South-South technological collaboration set out by the participating governments, particularly those of the emerging countries. The policies should articulate long-term strategic objectives, as suggested in this section.

The scientific and technical cooperation provided by agencies and the ongoing technological collaborations between firms should be better coordinated.

iii. Provide incentives to firms for technological collaboration and technology transfer

Technology has particular attributes, which implies that additional incentives are required for private sector actors to engage in technology transfer processes. This is be-

There is a need to provide greater incentives for technological collaboration and transfer of technology within the South-South context.

cause technology acquisition and exchange are mostly influenced by factors that are firm-based and profit-oriented. Firms in developing countries as well, despite having proved their competitiveness and technological edge, in many instances are constantly under pressure to compete and maintain/enhance their competitiveness vis-à-vis global TNCs. Thus, although firms from emerging countries may often be encouraged to enter into alliances for technological learning and technology transfer, in a large number of cases, these alliances need to be expressly promoted through policy measures.

In a survey of existing global trends in various sectors, the following aspects seemed to be particularly significant:

- There is emerging competition in certain sectors from firms in developing countries with developed-country firms;[12]
- Developing-country firms are able to strategically offer services/product partnerships on a quid pro quo basis over a longer term;[13]
- Developing-country firms are increasingly able to search efficiently for alternative technologies and pay their market price;
- There are a wide range of public-private initiatives aimed at technological exchange in certain sectors of public importance, such as agriculture and health.

Bearing this in mind, there is a need to provide greater incentives for technological collaboration and transfer of technology within the South-South context. These could take the following forms:

Public procurements can be used specifically to promote South-South technological collaboration.

- Offering special incentives and tax reductions to local firms from developing countries in return for entering into or attracting joint ventures or joint production arrangements in the South; and
- Granting local firms from developing countries special "development-friendly" certificates as a goodwill gesture that improves the corporate image of the firms and helps them to develop a customer base throughout the South.

2. Adopting policies that promote technological alliances and collaborations

Efforts to promote technological learning and innovation can be furthered by two important policy measures. One is public procurement, which has been used in several industrialized and developing countries. A specific and important function of public procurement can be to use large-scale purchases to induce domestic innovation (Edler and Georghiou, 2007). This stems from the understanding that demand is a key driver of innovation. Public demand, when driving innovative solutions and products, has the potential to generate improved innovation dynamics and benefits for the whole economy.

a. Technological learning through public procurement

Public procurement can be used in varying combinations to promote technological learning (box 4.11). An important public procurement combination is when governments procure strategically in cooperation with other partners in order to promote innovative capabilities in their countries. Many countries have used this as an innovation incentive, including promoting R&D spending among firms. For instance, the United Kingdom has tried for almost a decade to increase the impact of public procurement on R&D. More recently, the Chinese authorities have introduced public procurement which favours domestic producers with a similar aim.[14]

Public procurements can be used specifically to promote South-South technological collaboration. They can be structured so that foreign producers (specifically those from developing countries) are not shut out of the procurement competition process but are encouraged to bid collaboratively with local partners, with technology-sharing effects. The procurement conditions can include the requirement for technology-

Box 4.11: Different kinds of public procurement

Public procurement has been categorized in different ways depending on what is being procured, for whom and for what purpose. First a distinction can be made between general and strategic procurement. Any public procurement for simply fulfilling a need of the buying agency with off-the-shelf products is considered *general public procurement*. On the other hand, procurement is considered "strategic" when demand for certain technologies, products or services is encouraged in order to stimulate the market for those technologies, products and services locally. Others further categorize forms of innovative public procurement on the basis of the level of innovation being promoted. *Developmental procurement* refers to procurement that encourages technologies to be developed from the start, whereas *adaptive procurement* aims to encourage innovation of an existing technology so as to customize it to meet a particular need (Edquist and Hommen, 2000).

Yet another categorization of public procurement relates to the end user of the procurement. *Direct public procurement* refers to acquisitions where the end user of the procurement is the government itself, whereas cooperative public procurement refers to public agencies buying jointly with private purchasers for utilizing the bought innovations. *Catalytic public procurement* is when a State agency initiates the procurement but the innovation is used exclusively by private users (Edquist and Hommen, 2000; Edquist and Zabala-Iturriagagoitia, forthcoming).

Source: UNCTAD, based on various sources.

sharing between the local and the foreign partner to facilitate technological learning for the local partner(s) in the process. There are numerous examples of industrialized countries using this kind of procurement to promote domestic innovative capabilities that offer lessons for promoting such alliances in developing countries (box 4.12).

The Cipla Pharmaceuticals-Quality Chemicals case discussed in chapter III of this Report offers an example of an LDC government (Uganda) using public procurement as a means of fostering technological collaboration between its firm and an Indian company.

b. Strengthening and promoting technological alliances

As noted in chapter IV, in all high-tech sectors, strategic alliances between competing firms, or between firms and public or academic institutions, have become common modes of business interaction. These relationships, which are deeper than arm's-length market transactions but fall short of full mergers or acquisitions, are now understood as important drivers of innovative activity. Firms use strategic alliances for a variety of reasons, including for gaining access to new markets and technology, reducing the costs of inputs, and sharing certain risks with other firms. These arrangements allow them to utilize their

Box 4.12: The Intrakom-Ericsson alliance

The idea of developing local industrial capabilities in telecommunications equipment manufacturing was first conceived by Greek policymakers in the late 1970s in the context of a broader European trend to build national champions of rapidly growing industries. In the early 1980s, policymakers endorsed strong industrial policy objectives in government procurement practices to boost the economy and competitiveness, increase employment, and in the case of Greece, to establish domestic capacity in the rapidly expanding telecommunications equipment sector.

Intrakom was founded in 1977, and until the mid-1980s it was only a supplier of imported analog switches to the State telecom monopoly, OTE. As part of an alliance with Ericsson of Sweden in the late 1980s, Intrakon received a licence for the transfer of production and assembly know-how of important telecommunications equipment, and trained Greek engineers in Sweden. Growing public procurement from the alliance helped it to expand over the course of a decade to become a majority local producer of telecommunications equipment. By expanding in technological intensity it was able to make important contributions to software as well. Intrakom gradually shifted from a commerce-oriented company to a technology-intensive systems integrator. The technological sophistication acquired through the alliance helped Intrakom to begin exporting to Ericsson Sweden, and to enter into multiple licensing agreements with other international vendors (e.g. Marconi, Alcatel and GNC), as well as to engage in collaborative agreements with smaller local companies and universities.

Source: Based on Caloghirou, Constantelou and Karounos (2000).

resources more efficiently and improve their ability to quickly develop better products and processes. Concerning developing countries, alliances provide an avenue for indigenous firms to catch up with those of developed countries and thus help developing countries establish their own competitive industries.

Governments employ various policies to promote strategic partnerships and leverage their benefits. Elements of an innovation policy framework, including horizontal innovation policy measures for collaboration, were discussed earlier in this chapter. The kinds of policies that promote technological alliances are similar to those aimed at interactive learning in national innovation policy frameworks. There could also be additional policies that seek to eliminate inappropriate contractual behaviour at all stages (i.e. in searching, bargaining and enforcing contracts) by making sure that the private sector can engage in alliances and can expect positive returns from successful collaborations. Although such policies can take diverse forms, the three main kinds are discussed below.

The SITEP could be augmented by regional initiatives directly aimed at building innovation capacity at the regional level.

i. Competition policy

A policy measure to spur alliances, which has been employed by many industrialized countries, involves creating exemptions to competition laws that prohibit firms from restricting or distorting sectoral competition. The EU, for instance, exempts certain anti-competitive agreements as long as they contribute to technological or economic growth and provide consumers with a reasonable share of the benefits. In the United States, over several decades the courts have generally refrained from prosecuting broad alliances that focus on research and technological exchange. Adopting similar measures in developing countries for firms from the South would allow their firms some level of discretion when they promote technological learning in other local firms.

ii. Contract enforcement

Promoting alliances requires local courts to have a greater level of sophistication to be able to handle disputes in general, but also disputes involving issues relating, for example, to IPRs. Collaborating parties usually agree to some sort of contractual arrangements. However, legal certainty and efficiency in contract enforcement (through arbitration and courts) are usually required to promote trust and ensure compliance.

iii. Public subsidies

All governments that seek to promote innovation capacity have tended to use some programmes that fund collaborative undertakings. Such programmes do not need to target any specific activity or sector; they may simply accord preference to proposals that include more than one group of participants, with explicit technological learning milestones. This could be used to facilitate collaborative undertakings with firms from developing countries.

3. Addressing common challenges through SITEP

As mentioned in section F of this chapter, the SITEP would provide institutional support at three levels: promote technological learning at the firm level, promote enterprise development and financing of specific innovation activities that are of particular importance to developing countries as a whole, and act as a platform for sharing innovation experiences and promoting policy learning. The SITEP could be augmented by regional initiatives directly aimed at building innovation capacity at the regional level. Some such initiatives have already been conceived, such as the African Union Pharmaceutical Manufacturing Plan (discussed in chapter III) and the South-South Cooperation Multi-Donor Trust Fund. The Fund aims to address current constraints on South-South technological collaboration by acting as a focal point for policy formulation and implementation.[15] Details of how the SITEP would provide all these forms of support are discussed below.

a. Technological learning at the firm level

A number of developing countries, in particular emerging countries, are increasingly producing new, state-of-the-art technologies. Many of these efforts are being financed by public investment. A mechanism

that could advance access and production of knowledge among countries of the South would be to pool together public investment for basic R&D as a means of promoting both the development of domestic learning capabilities as well as linkages and interactions among actors in innovation systems across developing countries. A model of this kind is the Competitiveness and Innovation Framework Programme of the European Union[16] that stimulates such linkages across Europe. Again, South-South collaboration will need to rely on the provision of incentives to domestic firms and other actors to engage in innovation and technology development so that they are not driven solely by market signals.

i. South-South research and product development hubs

Enterprises that develop and apply some technologies, especially those in sectors of particular public interest such as pharmaceuticals and agriculture, need a supportive infrastructure, which can often be technology-intensive and costly. For instance, pharmaceutical enterprises seeking to produce good quality generic drugs require testing and bioequivalence laboratories as well as common facilities, such as active pharmaceutical ingredients (APIs) parks, to be able to produce cost-effectively and to requisite standards. The same is true for many other sectors. Regional R&D facilities to create and sustain R&D within firms or those which provide R&D services on a pay-as-you-go basis could constitute an important short- and medium-term solution to some of the major problems faced by public and private sectors in developing countries. Some initiatives that rely on such a model already exist, such as the Engineering Capacity Building Programme of the Germany International Cooperation Agency (GIZ). The GIZ is providing some finance and technical assistance to set up a bioequivalence facility for the East African Region in collaboration with two pharmaceutical companies from Kenya, one from the United Republic of Tanzania and one from Ethiopia's School of Pharmacy of the University of Addis-Ababa.[17]

Such regional R&D facilities could be created by developing countries, particularly LDCs, and supported through the international community or through South-South collaboration or even as a triangular facility between the LDCs, other developing countries (offering technical know-how and training) and developed countries (offering financial support). This could be used to create a series of pay-as-you-go facilities for sectors in which firms face difficulties in raising capital for infrastructure expansion. The regional R&D funds could also set research priorities for technological expansion of firms in particular sectors that are especially important, such as green technologies, medicines and regionally suited crop varieties, among others.

ii. South-South pooling of supply and demand

The SITEP, in addition to promoting partnerships in R&D, could provide greater incentives for the pooling of regional domestic demand for particular products and processes that are more capital- and research-intensive.

The SITEP can provide greater incentives for the pooling of regional domestic demand for particular products and processes.

A major impediment to many technological innovations is the limited or lack of local/regional market demand. In countries such as Brazil, China and India, their sizeable domestic markets have been a major incentive for local firms to invest in the development of new products and processes. This is particularly true in industries where technological innovations are investment-intensive and risky, such as in health technologies. The economies of scale and scope made possible by large local markets are very important for several sectors, but in many developing countries, such as in Africa, local markets tend to be small and regional distribution systems do not function well. In many cases, local firms are constrained in supplying to regional markets because of perception or marketing issues, and this often results in production inefficiencies and losses. Aggregating demand, for instance for vaccines or other health-related products, is already under discussion in many other international forums. Such initiatives

do not need to be restricted only to a regional level; they could be wider in scope, across like-minded countries that have similar needs within the South.

b. Enterprise development and financing of innovation activities

The proposed SITEP would have a second set of institutional measures and activities that are directly geared to alleviating many of the constraints faced at the enterprise level, including financing that could take various forms as discussed below.

i. Venture capital funding at the regional level

Emerging enterprises in LDCs that show promise in key sectors of regional importance, such as pharmaceuticals, agro-processing and ICTs, could be provided with venture capital funding. Such funding programmes could offer awards through contests for participating regional firms (Gallini and Schotchmer, 2002).

Developing countries could benefit enormously from building a common forum for exchange of information about their national technology and innovation policies.

ii. Co-investment with private investors in innovative enterprises

A number of schemes could be launched at the regional level for the development of early-stage innovative technologies by local firms. Acquisition of technological know-how could be supported through public-private/private-private partnerships between various developing countries. A good example is the technology-sharing arrangement between Quality Chemicals (Uganda) and Cipla Pharmaceuticals (India) for the production of antiretroviral drugs (see chapter III). As this case demonstrates, technology-sharing offers a promising means of building capacity, but it may require co-investment involving governments and private enterprises in developing countries and LDCs.

iii. Financing for collaboration between private and public enterprises

This scheme could expressly address the lack of incentives at the national/sectoral levels in developing countries so as to enable collaborative linkages. A good example of such an ongoing initiative is the Millennium Science and Technology Initiative in Uganda – a project sponsored by the World Bank that has specific funds earmarked for collaborative initiatives between private and public enterprises.[18]

c. Sharing of existing information on innovation and technologies

There are hundreds of existing innovations in developing countries that may not be proprietary technologies, which could be shared with other developing countries to address their needs. However, their existence may not be known. The SITEP could create a system for sharing information on existing technologies appropriate for developing-country needs, particularly for providing solutions that are pro-poor. This could take the form of a centralized database, similar to what India and other countries have asked the WTO to set up under the Working Group on Trade and Transfer of Technology.

Developing countries could benefit enormously from building a common forum for exchange of information about their national technology and innovation policies. Such a forum would enable the sharing of experiences on how countries could promote industrial development within the parameters of the international trade and IPR regimes. The forum would provide a venue for discussions on the options and flexibilities that are still currently available under the existing international rules. In areas such as IPR protection, for example, international rules can inhibit imitation and reverse engineering of technology for local adaptation and learning, as well as interfere with government procurement, which is a means of targeting technological priorities and aiding domestic firms. Trade rules may similarly reduce the ability to promote domestic industry or protect local infant industries threatened by foreign competition. However, there are many areas where intervention is still possible, including financing of basic research to promote the development of local capabilities, investment in education and procurement to stimulate innovation in domestic firms. Sharing of experiences on how this can be done and in what instances is critical.

Creating a forum for South-South collaboration and exchange of experiences and practices on innovation and technology policy is by no means a radical idea. Such exchanges often take place, for instance among EU countries, and analyses on the subject are regularly undertaken by the OECD (see, for example, OECD, 2007).

d. Coordination with other regional initiatives

In order to achieve the best results, the SITEP should be coordinated with other ongoing regional and international initiatives, such as the Turkish Innovation Network.[19] In specific sectors, other initiatives may also be relevant, such as the UNFCCC's Technology Mechanism which promotes climate change mitigation and adaptation technologies, or the African Pharmaceutical Manufacturing Plan for health-related technologies. Regional initiatives could be supportive of SITEP's aims to further enhance its effectiveness.

H. SUMMARY

This chapter has explored the key issue of how South-South collaboration can provide greater impetus to overall technological learning and the building of innovation capabilities in developing countries. It calls for an international framework to promote South-South technological exchange with a view to realizing the potential of South-South collaboration for building technological capabilities. Such a framework, which is critical for providing a clear road map for action, should be based on the following key principles:

a. Address the technological needs of developing countries, particularly LDCs;

b. Aim at knowledge sharing and learning from the catch-up experiences of various developing countries for building innovation capabilities;

c. Promote important means of technological learning, particularly through technological alliances and technology transfer initiatives;

d. Make South-South FDI more technology oriented; and,

e. Pool developing-country resources to address common technological challenges.

With regard to the final principle of pooling resources to address common technological challenges, this chapter proposes a South-South Technology and Innovation Pact (SITEP) for enabling various means of technological collaboration aimed at alleviating the binding constraints on innovation capacity at three levels: learning at the firm/organizational level, financing innovation activities and enterprise development, and finally providing new means of sharing existing technological information.

This chapter has also highlighted policy measures that could be implemented at the national, regional and international levels to operationalize these principles. It is suggested that innovation policy needs to clearly view South-South collaboration as a means of addressing learning of the kind required and identified by assessments of the national innovation systems of countries. These policy measures need to be accompanied by incentives in developing countries that are based on a longer term vision of South-South technological exchange within their broader economic engagement with developing-country partners. These policy measures need to be coordinated with explicit incentives for scientific and technical cooperation on the one hand, and firm-level incentives on the other. The chapter also identifies policy measures that could be used to promote important means of technological learning, namely through public procurement and technological alliances. Finally, the chapter elaborates the operational details of the proposed SITEP which could help implement several of the principles described in the chapter. This includes the sharing of innovation experiences and the promotion of joint responses to common technological needs.

In order to achieve the best results, the SITEP should be coordinated with other ongoing regional and international initiatives.

NOTES

1. In keeping with the definition of innovation capacity used in this Report, "new" here denotes new locally, or new to the region or to the world at large.
2. See table 2.9 and figure 2.12 in chapter II, which show that the services sector accounts for over 50 per cent of all FDI from developing countries.
3. See also Katz (1973 and 2000) and Katz and Ablin (1987), who present case studies on manufacturing firms in Latin America that support this finding.
4. See chapter II for a discussion on the technology implications of GPNs.
5. A variety of national science, technology and innovation policy reviews (STIPS) conducted by UNCTAD have reached a similar conclusion (see, for example, UNCTAD, 2010b and 2011d).
6. See Hausmann, Hwang and Rodrik (2005), who establish a link between specialization patterns of economies and income levels.
7. For instance, India has been experimenting with various provisions in its pharmaceutical patent regime after 2005 that still allow local firms to continue producing generic versions of drugs that are important for public health.
8. A forward linkage can be promoted when a firm produces inputs that reduce the costs to its customer firms or raises the quality of its products, and a backward linkage can be promoted when the firm's operations increase demand for inputs from its local supplier companies and when the firm tries to improve the technologies and standards used by its supplier companies.
9. Such alliances, also known as strategic alliances, are particularly prevalent in knowledge-intensive industries. They refer to the increasing use of various kinds of cooperative agreements, such as joint ventures, joint R&D projects, technology exchange agreements, co-production, direct minority investments and sourcing relationships, to advance core strategic objectives (see, for example, Malerba and Vonortas (2009), Caloghirou, Constantelou and Krounos, 2000, Hagedoorn, 2002; and Vonortas, 1997.)
10. Efforts to operationalize the UNFCCC's provisions on technology transfer culminated in the creation of the TM, as agreed at the 16th Conference of the Parties (COP) in Cancun in 2010, building further on the earlier mandates from the Bali Action Plan of 2007 (see, for example, Gehl Sampath et al., 2012; Ahmed et al., 2012; and Correa, 2012).
11. This emphasis on identification of technological needs of countries has become an important aspect of promoting technological capacity in several contexts, including international forums. The Technology Mechanism of the UNFCCC for capacity-building on climate change technologies, for instance, aims to identify the technological needs of developing countries in sectors relevant to climate change technologies. Similarly, many other approaches on technological collaboration are based on a clear and cogent identification of technological needs by recipient countries.
12. This is often the case when firms in developing countries are able to reverse engineer the technologies and products in question and are adept at incremental innovation. Many companies cite the possibility of easy replication and capture of rents by local firms as a reason for not engaging in technology exchange or even aggressively protecting their technologies.
13. In some emerging sectors, technology alliances are often promoted due to the fact that the international firms lack some of the services/distribution/efficient product development capacities that the local firms offer, and which are often needed to gain a foothold in the local/regional market.
14. For example, the fast-growing Chinese company, Huawei, grew domestically under exclusive supplier agreements with the Chinese public telecommunications network (discussed in chapter III).
15. It is expected that the main objective of the fund, to be implemented by the African Development Bank, will be to support African countries in mobilizing and taking advantage of development solutions and technical expertise available in other developing countries.
16. http://ec.europa.eu/cip/
17. The lack of bioequivalence facilities that can prove that a local product is biologically equivalent to its branded counterpart has hindered African local producers. Since the setting up of such a facility is a very skill- and finance-intensive task, this example demonstrates how countries can pool resources for such purposes to promote innovation in a regional context.
18. www.worldbank.org/projects/P086513/millennium-science-initiative
19. See discussion in Chapter III.

EPILOGUE

EPILOGUE

As more and more developing countries embark on the process of industrial catch-up, the time is ripe to begin conceptualizing how and to what extent South-South collaborations can help address specific development goals in the developing world. This Report has analysed the potential of the South for furthering one such goal: bridging the technological divide as a means to promoting industrialization within the developing world as a whole and contributing to inclusive globalization.

An overwhelming policy consideration for developing countries is how South-South cooperation could be oriented and harnessed to foster technological and innovation capacity in developing countries. How can the technology needs of all developing countries and LDCs be integrated into a balanced agenda of cooperation and exchange? Given the limited data available on technology trends in developing countries, this Report has sought to contribute new policy insights in this complex area.

The findings of the Report have significant implications for policy and practice. Firstly, the analysis shows that there are a large number of ongoing projects and initiatives for technology exchange among developing countries and LDCs, both government-initiated and private-sector-based, which vary in scale and scope. The data and trends analysed show that, currently, South-South trade and technology flows are quite similar to North-South trade and technology flows, with some variations. The greatest advantage of South-South collaboration is that it offers a choice to developing countries to tailor their partnerships in a way that certain broader social and economic goals are served. In addition, emerging country partners may have a better understanding of the ways and means of overcoming innovation constraints facing other developing countries, and they may have more cost- and context-effective technologies. These advantages need to be consciously exploited. In order to ensure that the current and projected trends in South-South trade and investment assist in the broader goal of learning and capabilities-building, this Report has argued that technology and innovation issues should be given priority in the South-South discourse.

Secondly, in order to harness the potential of South-South collaboration for bridging the technology divide, the Report argues that, as a first step in fostering such collaboration for technology and innovation, it is necessary to move beyond a simple affirmation of broad normative principles; there needs to be an understanding of the main issues and opportunities available in this area. Existing lessons on how best to promote technological change in the developing-country context offer an automatic starting point to understand and foster South-South cooperation in this area. But at the same time, there are some outstanding issues that remain. What are the technologies that are urgently needed, and how best can South-South cooperation foster their exchange? How can these technologies be identified? Is there a need to refine our understanding of technology exchange and flows, in order to develop a positive agenda for promoting technological capabilities? How can the technology needs of all the developing countries, particularly LDCs, best be included, with regard to building local absorptive capacity and dynamic capabilities for production? What kinds of appropriate technologies are required?

Thirdly, in order to effectively address these issues, *TIR 2012* proposes the articulation of a set of principles on which a framework for South-South collaboration for technology and innovation can be structured. Such a framework is needed for many reasons. To begin with, short-term objectives of trade and access to inputs for industrialization processes may be at odds with the overall

technological development goals of the developing world as a whole. A framework for South-South collaboration could therefore help in aligning these with the interest of all developing countries.

Moreover, although technology and knowledge are key inputs to the catching up and convergence processes through which developing countries absorb ideas and concepts from the industrial frontier, the accumulation of technological capabilities requires specific policy and institutional support by the international community and by the developing countries themselves. As part of such a framework, *TIR 2012* therefore calls for a strengthening of South-South cooperation with a particular focus on *collaboration for technology and innovation*. Such interaction should take place at three different levels:

i. Exchange of innovation policy experiences (and best practices) and policy frameworks for technology and innovation;

ii. Technology exchange and flows aimed at increasing technology absorptive capacity in the private and public sectors; and

iii. Transfer of technologies in key sectors of importance to public well-being, such as agriculture, health, climate change and renewable energy.

Fourthly, the Report proposes five principles as the basis of a South-South framework on technology and innovation. The principles which help to promote interaction at all the three levels identified here are the following:

i. Prioritize the technological needs of the other developing countries and LDCs;

ii. Aim at sharing and better integrating the lessons learned from the ongoing catch-up experiences of other developing countries in building innovation capabilities through proactive policies;

iii. Promote important means of technological learning, particularly through alliances and technology transfer initiatives;

iv. Make South-South FDI more technology oriented; and

v. Pool developing-country resources to address common technological challenges.

Finally, the development of productive capacities in any country is strongly influenced by institutions that constrain or restrain processes of capital accumulation, technological progress and structural change. In addition to sensitizing national institutional frameworks on technology and innovation for greater South-South collaboration, a range of regional institutional frameworks are also required to facilitate this focus. If these already exist, they may need to be revised or adapted to promote South-South cooperation geared specifically to technology and innovation.

International support to this effort through various channels will be necessary, including financial support and North–South, South–South and triangular cooperation and effective technology transfer mechanisms. Several policy measures at the national, regional and international levels are suggested as a final step in order to help implement the principles set out in the Report. The adoption of such measures would mark the initiation of a process of positive engagement to promote South-South collaboration in technology and innovation.

A specific policy instrument, the South-South Technology and Innovation Pact (SITEP) has been proposed to provide institutional support at three levels: to promote technological learning at the firm level, to promote enterprise development and financing of specific innovation activities that are of particular importance to developing countries as a whole; and to act as a platform for sharing innovation experiences and promoting policy learning.

Given their similar development contexts, the Report recognizes that the innovation experiences and technological strengths of some developing countries makes them

natural strategic partners with other developing countries in efforts to bridge the technological divide. Furthering this role calls for creating the right basis for accessing science, technology and innovation resources within the developing world. Technology and innovation resources of the South will be critical to link firms and organizations in other developing countries and LDCs with the global knowledge economy to accelerate their development processes. This needs to be based on an understanding that (i) innovation is a multi directional, highly interactive process that integrates or "articulates" science, technology and production, and that (ii) new policy thinking is needed to help establish virtuous circles of rising productivity, technological progress and structural transformation across the entire developing world.

There are many outstanding issues concerning technological learning and innovation capacity in the context of developing countries, which need to be addressed at the international level. Developing countries can lead the way by working together and providing constructive solutions to the unresolved policy challenges in the coming years.

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ANNEXES

ANNEX I

COUNTRY GROUPINGS USED IN THIS REPORT

Major economic areas

The classification of countries and territories according to main economic areas used in this document has been adopted for purposes of statistical convenience only and follows that in UNCTAD's Handbook of International Trade and Development Statistics 2011. Countries and territories are classified according to main economic areas as follows:

Developed economies: Andorra, Austria, Belgium, Bulgaria, Bermuda, Canada, Cyprus, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Gibraltar, Greece, Greenland, Holy See, Hungary, Iceland, Ireland, Italy, Israel, Japan, Latvia, Lithuania, Luxemburg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Saint Pierre and Miquelon, San Marino, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

European Union: Andorra, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Faeroe Islands, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.

Transition economies: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Montenegro, Republic of Moldova, Russian Federation, Serbia, Tajikistan, the former Yugoslav Republic of Macedonia, Turkmenistan, Ukraine, Uzbekistan.

All developing countries: All other countries, territories and areas in Africa, Asia, America, Europe and Oceania not specified above.

Newly industrialized economies, 1st tier: Hong Kong (Special Administrative Region of China), Republic of Korea, Singapore, Taiwan Province of China.

Newly industrialized economies, 2nd tier: Indonesia, Malaysia, Philippines, Thailand.

Least developed countries

Afghanistan, Angola, Bangladesh, Benin, Bhutan, Burkina Faso, Burundi, Cambodia, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, the Gambia, Ghana, Guinea, Guinea-Bissau, Haiti, Kenya, Kiribati, Lao People's Democratic Republic, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mozambique, Myanmar, Nepal, Niger, Rwanda, Samoa, Sao Tome and Príncipe, Senegal, Sierra Leone, Solomon Islands, Somalia, Sudan, Timor-Leste, Togo, Tuvalu, Uganda, United Republic of Tanzania, Vanuatu, Yemen, Zambia.

LDCs geographical classification

African LDCs (and Haiti): Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Ethiopia, the Gambia, Guinea, Guinea-Bissau, Haiti, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Somalia, Sudan, Togo, Uganda, United Republic of Tanzania, Zambia (32).

Asian LDCs: Afghanistan, Bangladesh, Bhutan, Cambodia, Lao People's Democratic Republic, Myanmar, Nepal, Yemen (8).

Island LDCs: Comoros, Kiribati, Maldives, Samoa, Sao Tome and Príncipe, Solomon Islands, Timor-Leste, Tuvalu, Vanuatu (9).

Other country groupings

DAC member countries: The countries of the OECD Development Assistance Committee are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxemburg, Netherlands, New Zealand, Norway, Portugal, Republic of Korea, Spain, Sweden, Switzerland, United Kingdom, United States.

Non-DAC member countries reporting to the OECD-DAC: Czech Republic, Hungary, Iceland, Mexico, Poland, Slovak Republic, Turkey, Thailand and Arab countries (Algeria, Iran (Islamic Republic of), Iraq, Kuwait, Libya, Qatar, Saudi Arabia, United Arab Emirates).

Annex II

Table A.II.1: Real GDP growth rates, 1980–2010 (Per cent)

Year	Economy												
	Global		Regional			Asia				Selected developing countries			
	Developed countries	Developing countries	Africa	Latin America and the Caribbean	Asia	East Asia	South Asia	South-East Asia	West Asia	Brazil	China	India	South Africa
1980	0.3	4.68	3.59	6.31	3.63	4.98	0.96	6.37	2.93	9.23	7.8	6.62	..
1985	3.76	3.72	3.16	3.33	4.16	8.92	4.57	0.44	-0.07	7.85	13.5	5.47	..
1990	2.65	3.96	2.64	0.52	6.48	5.75	6.51	8.33	6.55	-4.35	3.79	5.66	..
1991	0.96	4.23	1.56	3.36	5.34	8.65	3	7.01	0.46	1.03	9.21	0.42	..
1992	2.09	5.31	-0.14	2.84	7.92	9.73	5.68	6.72	7.27	-0.54	14.19	5.42	..
1993	1.11	5.31	0.43	3.45	7.31	9.86	2.98	7.56	5.87	4.92	14	4.95	..
1994	3.08	5.73	2.49	4.75	6.87	10.41	5.6	8.05	0.04	5.85	13.1	7.46	..
1995	2.57	4.84	2.63	0.71	7.45	8.98	6.45	8.12	4.47	4.22	10.9	7.65	..
1996	2.73	5.91	5.46	3.53	7.2	8.11	6.61	7.46	5.45	2.15	10	7.39	..
1997	3.3	5.57	3.23	5.27	6.11	7.42	4.09	4.39	6.19	3.38	9.3	4.48	..
1998	2.8	1.97	2.97	2.41	1.61	2.56	5.02	-7.79	3.65	0.04	7.8	5.99	..
1999	3.33	3.63	2.74	0.67	5.21	7.86	6.01	3.63	-0.62	0.25	7.6	7.13	..
2000	3.88	5.78	3.46	4.41	6.79	8.11	4.04	6.15	6.43	4.31	8.4	4.03	4.15
2001	1.51	2.8	3.98	0.72	3.57	5.51	4.31	2.38	-1.3	1.31	8.3	5.22	2.74
2002	1.46	4.24	3.59	0.5	6.01	7.74	4.61	4.87	3.38	2.66	9.1	3.77	3.67
2003	1.9	5.3	4.97	1.8	6.83	7.08	7.76	5.62	6.09	1.15	10	8.37	2.95
2004	2.97	7.42	7.93	5.81	8	8.27	7.49	6.54	8.84	5.71	10.1	8.3	4.55
2005	2.45	6.8	5.45	4.58	7.87	8.63	8.24	5.8	6.86	3.16	11.3	9.32	5.28
2006	2.88	7.61	6.08	5.57	8.61	9.95	8.31	6.17	6.75	3.96	12.7	9.27	5.6
2007	2.58	7.91	6	5.6	9.04	11.02	9	7.03	4.5	6.09	14.2	9.82	5.57
2008	-0.09	5.08	4.77	3.92	5.55	6.92	4.1	4	3.81	5.16	9.6	4.93	3.58
2009	-3.97	2.52	0.89	-2.15	4.39	5.93	6.9	1.29	-1.1	-0.64	9.2	9.1	-1.68
2010	2.66	7.48	3.99	5.98	8.44	9.53	7.14	7.99	6.36	7.49	10.4	8.81	2.84

Source: UNCTAD secretariat, based on UN-DESA Statistic Division, National Accounts Main Aggregates Database.
Note: Growth rate is based on GDP at constant 2005 United States dollars.

Table A.II.2: Evolution of South-South and South-North trade across regions, 1995–2010 (Per cent)

Economy	Year	Partner									
		Developing countries	Latin America and the Caribbean	Southern Africa	South Asia	South-East Asia	East Asia	Brazil	India	China	South Africa
Developing countries	1995	39.76	28.56	..	38.06	43.90	45.44	36.86	34.25	49.13	..
Developed countries		58.22	70.73	..	59.39	55.62	53.56	62.40	63.72	49.17	..
Others		2.02	0.71	..	2.55	0.49	1.00	0.75	2.03	1.69	..
Total		100	100	..	100	100	100	100	100	100	..
Developing countries	2000	40.54	23.82	38.91	43.38	47.71	45.44	34.43	40.60	44.84	38.11
Developed countries		57.64	75.59	60.85	53.78	51.98	53.68	64.59	56.73	53.70	61.65
Others		1.82	0.60	0.24	2.84	0.31	0.88	0.98	2.67	1.46	0.24
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2005	48.34	31.24	40.14	49.98	57.48	50.32	44.01	48.79	44.98	41.36
Developed countries		49.33	67.91	59.60	47.03	41.93	48.08	54.41	48.84	52.92	58.38
Others		2.33	0.85	0.25	2.99	0.60	1.60	1.58	2.37	2.09	0.25
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2010	54.65	39.67	51.33	60.77	63.90	54.03	52.07	59.62	47.67	51.53
Developed countries		43.17	59.56	48.27	36.14	35.34	43.88	46.14	38.13	49.66	48.05
Others		2.17	0.77	0.40	3.10	0.76	2.09	1.79	2.25	2.66	0.42
Total		100	100	100	100	100	100	100	100	100	100

Source: UNCTAD secretariat calculations, based on UNCTADstat, GlobStat - Merchandise Trade Matrix.

Table A.II.3: Share of developed and developing countries and transition economies in total outward FDI, 1980–2010 (Per cent)

Year	Developed countries	Developing countries (excl. LDCs)	LDCs	Transition economies
1980	93.81	5.73	0.45	..
1981	96.92	2.97	0.11	..
1982	90.38	8.94	0.68	..
1983	94.60	5.24	0.17	..
1984	95.21	4.67	0.12	..
1985	93.61	5.97	0.42	..
1986	94.71	5.54	-0.25	..
1987	95.27	4.67	0.06	..
1988	93.40	6.47	0.13	..
1989	91.56	8.40	0.04	..
1990	95.07	4.93	0.00	..
1991	93.19	6.63	0.18	..
1992	87.80	11.34	0.09	0.77
1993	83.36	16.18	0.04	0.43
1994	83.32	16.52	0.05	0.11
1995	84.49	15.34	0.00	0.17
1996	83.32	16.43	0.01	0.24
1997	83.53	15.64	0.11	0.72
1998	92.50	7.39	-0.10	0.20
1999	93.60	6.16	0.03	0.21
2000	88.72	10.95	0.06	0.26
2001	88.52	11.15	-0.03	0.37
2002	90.13	8.88	0.10	0.88
2003	89.93	8.13	0.05	1.89
2004	85.21	13.23	0.04	1.53
2005	83.48	14.86	0.06	1.61
2006	81.41	16.87	0.05	1.68
2007	83.24	14.35	0.07	2.35
2008	80.27	16.49	0.17	3.07
2009	73.00	22.75	0.09	4.16
2010	68.18	27.36	0.21	4.25

Source: UNCTADstat, Outward Foreign Direct Investment Flows.

Table A.II.4: Trends in LDCs' exports of primary commodities to developed and developing countries, LDCs and others, 1995–2010 (Per cent)

Year	Partners			
	Developed countries	Developing countries (excl. LDCs)	LDCs	Others
1995	57.99	38.46	2.48	1.07
1996	55.55	40.99	2.00	1.46
1997	54.12	43.68	1.90	0.30
1998	57.92	38.91	2.49	0.67
1999	50.30	47.23	2.16	0.31
2000	48.03	49.88	1.60	0.49
2001	51.43	46.35	1.73	0.49
2002	52.50	45.10	1.97	0.43
2003	49.62	46.82	2.97	0.59
2004	43.88	53.32	2.27	0.53
2005	49.62	48.46	1.57	0.35
2006	46.21	52.10	1.31	0.38
2007	44.55	54.01	1.12	0.31
2008	46.56	52.24	0.96	0.24
2009	40.30	57.70	1.64	0.36
2010	39.37	58.71	1.59	0.33

Source: UNCTADstat.

Table A.II.5: Imports of capital goods by developing and developed countries from developing country regions and selected countries, 1995–2010 a (Per cent)

Economy	Year	Partner									
		Developing countries	Latin America and the Caribbean	Southern Africa	South Asia	South-East Asia	East Asia	Brazil	India	China	South Africa
Developing countries	1995	35.36	30.42	..	32.45	44.13	45.52	44.25	35.45	44.73	..
Developed countries		62.21	68.80	..	65.00	55.43	53.73	54.52	62.28	54.61	..
Others		2.43	0.79	..	2.56	0.44	0.75	1.24	2.27	0.66	..
Total		100	100	..	100	100	100	100	100	100	..
Developing countries	2000	39.96	22.63	47.14	35.20	45.03	42.19	40.46	38.90	38.85	48.05
Developed countries		57.63	76.83	52.61	62.92	54.81	57.23	58.43	59.22	60.45	51.68
Others		2.41	0.53	0.25	1.88	0.16	0.59	1.12	1.88	0.70	0.26
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2005	49.03	30.20	47.32	45.60	55.04	45.54	49.94	49.02	38.03	51.11
Developed countries		48.25	69.20	52.32	52.96	44.46	52.79	48.37	49.73	60.05	48.53
Others		2.72	0.60	0.35	1.43	0.50	1.68	1.69	1.26	1.92	0.36
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2010	53.99	39.27	57.90	56.06	62.57	50.21	60.24	59.16	42.87	59.77
Developed countries		43.78	60.02	41.46	42.36	36.67	47.03	37.91	39.44	53.92	39.54
Others		2.23	0.71	0.64	1.57	0.76	2.76	1.86	1.40	3.22	0.68
Total		100	100	100	100	100	100	100	100	100	100

Source: UNCTADstat, GlobStat - Merchandise Trade Matrix, Imports.

a Table depicts imports across developing and developed countries from developing countries. The regional disaggregation is also presented.

Table A.II.6: Trends in exports of manufacturing goods from developing countries to the rest of the world, 1995–2010 (Per cent)

Exports of developing countries to:	1995	2000	2005	2010
Developed countries	53.56	57.85	50.58	43.11
Developing countries (excl. LDCs)	43.05	39.55	46.47	53.28
LDCs	1.87	1.52	1.18	1.6
Others	1.52	1.08	1.77	2.01
Total	*100*	*100*	*100*	*100*

Source: UNCTADstat, Outward Foreign Direct Investment Flows.

Table A.II.7: Trade flows of Asian developing countries: intra-group and with rest of the world, 1995–2010 (Per cent)

Year		Partner		
		East Asia	South Asia	South-East Asia
1995	Intra-group	29.50	5.19	24.41
	Rest of the world	70.50	94.81	75.59
	Total trade of group	100	100	100
2000	Intra-group	28.31	4.64	22.98
	Rest of the world	71.69	95.36	77.02
	Total trade of group	100	100	100
2001	Intra-group	29.18	5.59	22.34
	Rest of the world	70.82	94.41	77.66
	Total trade of group	100	100	100
2002	Intra-group	31.19	5.54	22.65
	Rest of the world	68.81	94.46	77.35
	Total trade of group	100	100	100
2003	Intra-group	32.50	6.34	24.74
	Rest of the world	67.50	93.66	75.26
	Total trade of group	100	100	100
2004	Intra-group	32.76	6.24	24.91
	Rest of the world	67.24	93.76	75.09
	Total trade of group	100	100	100
2005	Intra-group	32.30	6.32	25.33
	Rest of the world	67.70	93.68	74.67
	Total trade of group	100	100	100
2006	Intra-group	31.97	7.76	24.93
	Rest of the world	68.03	92.24	75.07
	Total trade of group	100	100	100
2007	Intra-group	30.93	9.10	25.23
	Rest of the world	69.07	90.90	74.77
	Total trade of group	100	100	100
2008	Intra-group	29.13	9.00	25.55
	Rest of the world	70.87	91.00	74.45
	Total trade of group	100	100	100
2009	Intra-group	30.11	8.97	24.51
	Rest of the world	69.89	91.03	75.49
	Total trade of group	100	100	100
2010	Intra-group	28.40	8.53	24.59
	Rest of the world	71.60	91.47	75.41
	Total trade of group	100	100	100

Source: UNCTADstat, GlobStat - Intra-trade of Regional and Trade Groups, 1995-2010.

Table A.II.8: Imports of capital goods with high-technology intensity from developing country regions and selected countries, 1995–2010 (Per cent)

Economy	Year	Partner									
		Developing countries	Latin America and the Caribbean	Southern Africa	South Asia	South-East Asia	East Asia	Brazil	India	China	South Africa
Developing countries	1995	24.85	26.62	..	52.13	42.93	42.14	45.73	52.52	47.23	..
Developed countries		74.07	73.31	..	37.76	56.64	57.19	54.20	37.13	52.37	..
Others		1.08	0.07	..	10.11	0.43	0.67	0.07	10.36	0.41	..
Total		100	100	..	100	100	100	100	100	100	..
Developing	2000	30.23	18.69	62.86	58.82	44.13	43.50	34.96	60.25	43.77	66.97
Developed		68.71	81.24	37.00	32.85	55.76	56.11	64.96	31.39	55.84	32.90
Others		1.06	0.06	0.14	8.33	0.10	0.39	0.08	8.36	0.39	0.13
Total		100	100	100	100	100	100	100	100	100	100
Developing	2005	47.22	25.57	63.80	45.17	52.91	62.60	38.54	44.30	52.62	68.26
Developed		52.04	74.28	35.46	46.39	46.78	36.84	61.30	47.15	46.62	31.55
Others		0.74	0.15	0.74	8.44	0.31	0.56	0.16	8.56	0.76	0.19
Total		100	100	100	100	100	100	100	100	100	100
Developing	2010	53.04	34.14	58.60	47.60	54.61	64.67	59.69	47.39	54.13	61.10
Developed		46.23	65.35	40.74	45.06	44.82	33.89	39.89	45.41	43.74	38.18
Others		0.73	0.51	0.66	7.34	0.56	1.44	0.42	7.20	2.13	0.72
Total		100	100	100	100	100	100	100	100	100	100

Source: UNCTAD secretariat calculations, based on UNCTADstat, GlobStat - Merchandise Trade Matrix, Imports.

Table A.II.9: Imports of capital goods with medium technology intensity from developing country regions and selected countries, 1995–2010 (Per cent)

Economy	Year	Partner									
		Developing countries	Latin America and the Caribbean	Southern Africa	South Asia	South-East Asia	East Asia	Brazil	India	China	South Africa
Developing countries	1995	26.90	33.74	..	58.48	59.73	55.78	56.21	60.60	56.72	..
Developed countries		70.70	66.16	..	38.66	39.99	43.33	43.71	37.30	42.81	..
Others		2.40	0.10	..	2.86	0.28	0.89	0.08	2.10	0.47	..
Total		100	100	..	100	100	100	100	100	100	..
Developing countries	2000	29.34	26.06	48.66	56.21	54.00	48.39	54.78	57.10	48.07	48.31
Developed countries		68.77	73.85	51.06	41.84	45.76	50.68	45.08	41.99	51.28	51.40
Others		1.89	0.09	0.28	1.96	0.24	0.94	0.14	0.91	0.65	0.28
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2005	35.90	32.33	42.76	58.48	62.87	47.92	60.22	57.96	44.41	42.16
Developed countries		61.98	67.44	56.98	39.66	36.28	48.96	39.08	40.68	52.84	57.59
Others		2.12	0.23	0.25	1.85	0.85	3.12	0.70	1.36	2.75	0.25
Total		100	100	100	100	100	100	100	100	100	100
Developing countries	2010	40.64	38.78	47.10	59.59	66.86	55.42	72.55	58.10	51.77	46.26
Developed countries		57.59	60.90	52.21	38.55	32.07	39.93	27.12	40.37	43.45	53.03
Others		1.77	0.32	0.69	1.87	1.06	4.65	0.33	1.54	4.78	0.71
Total		100	100	100	100	100	100	100	100	100	100

Source: UNCTAD Secretariat calculations, based on UNCTADstat, GlobStat - Merchandise Trade Matrix, Imports.

Table A.II.10: Exports of high-technology manufactures, 1995–2010 ($ thousand)

Year	Emerging developing countries to developed countries	Emerging developing countries to LDCs	Developed countries to emerging developing countries	LDCs to emerging developing countries
1995	136 329 002.97	852 067.89	142 501 763.12	67 754.68
1996	142 185 238.95	883 597.43	146 503 033.24	44 418.88
1997	153 744 847.37	958 967.87	162 012 916.87	27 236.34
1998	157 434 949.65	880 575.79	144 660 929.14	29 143.48
1999	180 330 238.84	931 749.24	159 579 664.37	40 023.43
2000	219 625 725.13	1 132 937.60	195 559 289.47	44 611.53
2001	187 521 917.11	1 055 583.13	168 815 428.56	65 883.66
2002	185 385 651.29	1 082,513.52	162 591 902.05	29 909.60
2003	195 114 973.71	1 243 762.09	175 693 425.28	32 675.89
2004	231 046 565.27	1 576 210.64	209 645 582.74	87 601.14
2005	238 488 755.24	1 848 206.25	220 143 050.27	41 766.13
2006	268 998 054.18	2 230 507.02	243 445 009.88	44 519.41
2007	273 625 532.29	2 547 407.11	252 321 586.94	46 442.92
2008	277 398 967.75	3 094 449.71	272 793 367.15	112 072.41
2009	231 911 509.31	3 208 223.54	220 682 860.79	98 573.27
2010	295 016 265.93	4 154 579.02	280 266 157.79	82 110.42

Source: UNCTADStat, Merchandise Trade Matrix.

Table A.II.11: Imports per capita of machinery and transport equipment by developing countries and LDCs, 1995-2010 (per capita $)

Year	LDCs			Developing countries
	Oil exporters	Non-oil exporters	Total	
1995	22.0	14.6	35.8	152.0
1996	27.8	15.6	4.0	161.2
1997	33.0	15.1	4.8	169.3
1998	33.7	14.8	547.3	152.8
1999	35.1	14.5	1.0	157.1
2000	33.7	14.6	236.7	190.0
2001	49.2	14.9	118.8	178.5
2002	54.8	14.7	0.5	187.4
2003	66.2	16.9	124.1	216.2
2004	83.1	20.6	2.5	269.7
2005	114.9	23.0	104.5	306.7
2006	138.5	27.7	1.1	350.2
2007	164.0	31.9	1983.9	393.9
2008	214.2	38.9	26.5	430.3
2009	183.9	37.3	225.7	367.7
2010	198.1	41.4	71.9	462.3

Source: UNCTADstat.

Table A.II.12: Outward FDI from developing countries, 1970-2010 ($ million)

Year	Outward FDI	
	$ million at current prices	Per cent of total global outflows
1970	50.97	0.36
1971	45.04	0.31
1972	113.37	0.72
1973	129.70	0.50
1974	288.96	1.18
1975	536.12	1.87
1976	493.91	1.74
1977	616.39	2.14
1978	773.66	1.97
1979	430.56	0.68
1980	3 192.39	6.19
1981	1 584.13	3.08
1982	2 639.80	9.62
1983	2 020.72	5.40
1984	2 401.36	4.79
1985	3 962.13	6.39
1986	5 125.28	..
1987	6 722.56	4.73
1988	12 033.07	6.60
1989	19 762.41	8.44
1990	11 914.02	4.93
1991	13 476.89	6.81
1992	23 156.09	11.43
1993	39 319.03	16.21
1994	47 529.14	16.57
1995	55 723.59	15.34
1996	65 406.24	..
1997	75 218.26	15.75
1998	50 294.41	7.29
1999	67 344.79	6.19
2000	135 116.42	11.02
2001	83 087.38	..
2002	47 484.26	8.98
2003	46 667.57	8.18
2004	122 791.57	13.26
2005	132 507.00	14.91
2006	239 335.99	16.91
2007	316 863.45	14.42
2008	328 120.83	16.66
2009	268 475.98	22.85
2010	400 144.12	27.57

Source: UNCTADstat, GlobStat - Foreign Direct Investment: Inward and Outward Flows.

Table A.II.13: Share of FDI outflows by developing and developed countries in global FDI outflows, 1970–2010 (Per cent)

Year	Developing countries	Developed countries	Transition economies
1970	0.36	99.64	..
1975	1.87	98.13	..
1976	1.74	98.26	..
1977	2.14	97.86	..
1978	1.97	98.03	..
1979	0.68	99.32	..
1980	6.19	93.81	..
1981	3.08	96.92	..
1982	9.62	90.38	..
1983	5.40	94.60	..
1984	4.79	95.21	..
1985	6.39	93.61	..
1986	5.29	94.71	..
1987	4.73	95.27	..
1988	6.60	93.40	..
1989	8.44	91.56	..
1990	4.93	95.07	..
1991	6.81	93.19	..
1992	11.43	87.80	0.77
1993	16.21	83.36	0.43
1994	16.57	83.32	0.11
1995	15.34	84.49	0.17
1996	16.44	83.32	0.24
1997	15.75	83.53	0.72
1998	7.29	92.50	0.20
1999	6.19	93.60	0.21
2000	11.02	88.72	0.26
2001	11.11	88.52	0.37
2002	8.98	90.13	0.88
2003	8.18	89.93	1.89
2004	13.26	85.21	1.53
2005	14.91	83.48	1.61
2006	16.91	81.41	1.68
2007	14.42	83.24	2.35
2008	16.66	80.27	3.07
2009	22.85	73.00	4.16
2010	27.57	68.18	4.25

Source: UNCTADstat.

Table A.II.14: Share of FDI outflows in total FDI outflows from developing regions to the rest of the world, 1970–2010 (Per cent)

Year	Africa	Latin America and the Caribbean	Asia	Others
1970	36.78	61.25	1.96	..
1975	32.24	41.38	26.37	..
1980	34.35	28.15	36.93	0.56
1985	8.99	16.22	74.77	0.02
1990	5.53	2.53	91.85	0.09
1995	5.34	13.49	81.20	-0.03
2000	1.14	36.92	61.94	0.01
2001	-3.18	44.01	59.16	0.01
2002	0.60	25.67	73.68	0.04
2003	2.67	45.92	51.34	0.07
2004	2.11	23.40	74.44	0.05
2005	1.37	33.31	65.22	0.09
2006	3.44	33.29	63.26	0.02
2007	2.94	25.04	72.00	0.01
2008	2.41	29.57	68.00	0.03
2009	1.18	20.23	78.56	0.03
2010	1.76	29.97	68.23	0.04

Source: UNCTADstat.

Table A.II.15: Share of total FDI outflows from Asian subregions to the rest of the world, 1980–2010 (Per cent)

Year	East Asia	South Asia	South-East Asia	West Asia
1980	12.73	0.93	33.39	52.94
1990	87.49	0.09	21.27	-8.85
1995	74.17	0.29	26.89	-1.34
2000	85.11	0.66	10.73	3.50
2001	52.39	2.91	42.21	2.49
2002	79.63	5.08	6.05	9.24
2003	75.19	6.62	23.45	-5.26
2004	69.93	2.53	18.74	8.79
2005	60.07	4.08	21.45	14.41
2006	56.41	9.78	18.89	14.92
2007	50.15	8.80	26.12	14.93
2008	59.70	8.85	14.46	16.99
2009	68.10	7.78	15.64	8.48
2010	72.82	4.98	16.18	6.02

Source: UNCTADstat.

Table A.II.16: Share of primary commodities and manufactures in total LDC exports, 1995–2010 (Per cent)

Year	All food items	Agricultural raw materials	Fuels	Manufactured goods	Ores, metals, precious stones	Total
1995	20.88	13.76	24.19	22.19	18.97	100
1996	20.07	10.72	30.28	24.31	14.63	100
1997	19.35	11.50	28.87	26.88	13.40	100
1998	19.96	10.41	21.03	34.02	14.59	100
1999	17.51	9.11	28.51	32.12	12.75	100
2000	13.27	6.85	39.58	30.80	9.50	100
2001	13.84	6.55	37.09	31.05	11.48	100
2002	13.52	6.48	39.11	29.40	11.49	100
2003	12.63	7.68	41.19	28.28	10.22	100
2004	10.49	6.23	46.74	26.12	10.41	100
2005	9.03	5.03	54.41	21.50	10.03	100
2006	8.82	4.43	54.98	20.77	11.01	100
2007	8.41	4.43	57.65	19.34	10.17	100
2008	6.83	3.09	63.82	16.22	10.04	100
2009	9.70	3.83	53.44	21.78	11.25	100
2010	8.88	3.83	52.15	21.54	13.60	100

Source: UNCTADstat.

Table A.II.17: Number of scientific and technical journal articles in LDCs and selected countries, 1986–2007

Year	LDCs	Brazil	China	India	Indonesia	Malaysia	South Africa
1986	620	1 777	2 911	9 925	72	186	2 653
1987	573	1 766	3 146	9 051	66	192	2 670
1988	630	1 766	4 619	8 882	59	208	2 523
1989	586	2 117	5 411	9 744	86	241	2 499
1990	605	2 374	6 285	9 200	104	233	2 406
1991	599	2 640	6 186	9 517	89	260	2 552
1992	697	3 107	6 956	10 100	86	247	2 419
1993	696	2 885	7 566	9 763	103	293	2 377
1994	772	3 073	7 821	9 928	120	345	2 459
1995	845	3 436	9 061	9 370	130	366	2 351
1996	818	3 813	10 526	9 753	141	362	2 216
1997	837	4 498	12 172	9 618	146	349	2 223
1998	837	5 234	13 781	9 945	136	387	2 225
1999	882	5 859	15 715	10 190	163	471	2 303
2000	884	6 407	18 479	10 276	182	460	2 221
2001	874	7 052	21 134	10 801	189	472	2 291
2002	896	7 881	23 269	11 665	178	495	2 328
2003	968	8 330	28 768	12 461	157	479	2 205
2004	1 054	9 573	34 846	13 369	182	586	2 320
2005	1 077	9 897	41 604	14 635	205	615	2 395
2006	1 243	10 799	49 575	16 741	215	724	2 643
2007	1 327	11 885	56 806	18 194	198	808	2 805

Source: UNCTADstat.

Table A.II.18: Royalty and licensing payments and receipts in LDCs and selected countries, 1995-2010($ billion)

Payments (BoP, current $ billion)							
Year	LDCs	Brazil	China	India	Rep. of Korea	Malaysia	South Africa
1995	11 863 264.96	529 000 000.00	..	90 293 739.53	2 384 800 000.00	..	293 134 700.50
2000	40 326 861.57	1 414 582 000.00	1 280 970 000.00	282 463 092.35	3 221 100 000.00	546 052 631.58	245 895 910.25
2001	31 304 316.30	1 244 319 000.00	1 938 000 000.00	317 035 850.70	3 052 900 000.00	751 315 789.47	329 528 506.27
2002	48 541 595.70	1 228 789 000.00	3 114 004 040.65	345233 066.96	3 002 200 000.00	627 894 736.84	446 513 324.01
2003	38 350 391.09	1 227 928 000.00	3 548 126 751.60	549 887 942.05	3 570 000 000.00	782 000 000.00	616 743 679.49
2004	72 276 513.73	1 196 933 000.00	4 496 604 795.60	611 481 232.35	4 445 900 000.00	895 618 421.05	891 018 800.33
2005	62 520 583.02	1 404 494 000.00	5 321 253 863.35	671 829 366.32	4 560 800 000.00	1 369 655 659.02	1 070 615 302.41
2006	58 609 839.89	1 663 677 000.00	6 634 081 020.04	845 949 436.03	4 650 400 000.00	954 002 498.59	1 282 025 268.78
2007	42 388 941.38	2 259 433 000.00	8 192 067 402.33	1 159 824 390.71	5 133 800 000.00	1 185 193 311.43	1 596 250 884.98
2008	54 562 890.00	2 697 171 000.00	10 319 466 356.14	1 528 826 912.72	5 655 900 000.00	1 267 781 217.21	1 675 904 016.53
2009	53 917 095.36	2 512 044 100.00	11 065 271 082.00	1 860 283 808.19	7 187 600 000.00	1 133 119 332.94	1 658 023 464.64
2010	69 323 367.28	2 850 248 166.09	13 039 546 459.00	2 437 500 662.97	8 964 600 000.00	..	1 941 235 599.81
Receipts (BoP, current $ billion)							
Year	LDCs	Brazil	China	India	Rep. of Korea	Malaysia	South Africa
1995	9 402 434.00	32 000 000.00	..	1 395 550.26	299 200,000.00	..	44 672 003.89
2000	17 319 811.38	125 190 000.00	80 348 000.00	82 548 708.77	688 100,000.00	18 157 894.74	49 094 178.93
2001	5 920 521.99	112 092 000.00	110 000 000.00	37 156 159.54	923 500,000.00	20 789 473.68	21 490 396.23
2002	7 336 768.65	100 258 000.00	132 822 320.49	20 159 947.94	835 300,000.00	12 105 263.16	19 454 588.57
2003	23568 784.94	108 116 000.00	106 978 898.26	24 088 615.69	1 311 200,000.00	20 289 473.68	26 550 160.13
2004	230 587 943.01	114 479 000.00	236 359 258.21	52 796 059.57	1 861 100,000.00	41 510 526.32	37 391 888.59
2005	62 499 569.14	101 660 000.00	157 401 785.78	205 974 583.70	1 908 400,000.00	27 040 748.14	45 302 063.01
2006	14 929 012.26	150 307 000.00	204 503 785.23	60 913 260.31	2 045 600,000.00	26 163 153.07	45 784 149.46
2007	13 845 755.08	319 410 000.00	342 634 074.97	163 126 496.58	1 735 100,000.00	36 979 524.16	52 913 601.51
2008	87 894 561.76	465 444 000.00	570 536 223.22	147 815 443.39	2 381 700,000.00	199 256 272.64	53 737 885.62
2009	43 215 521.15	433 807 800.00	429 452 520.00	192 555 770.14	3 199 100,000.00	265 724 707.23	47 725 840.34
2010	9 200 706.23	397 212 729.82	830 483 814.00	128 724 356.19	3 145 800,000.00	..	59 186 453.85

Source: UNCTADstat. Note: BoP = Balance of payments.

Table A.II.19: Composition of merchandise exports of LDC oil exporters and non-oil exporters, 1995-2010 (Per cent)

Year	LDC oil exporters					LDC non-oil exporters				
	All food items	Agricultural raw materials	Fuels	Manufactured goods	Ores, metals, precious stones	All food items	Agricultural raw materials	Fuels	Manufactured goods	Ores, metals, precious stones
1995	5.72	7.79	3.02	81.69	1.78	26.56	16.00	24.94	2.66	29.84
1996	5.51	5.42	3.43	84.26	1.38	27.22	13.32	20.12	3.78	35.56
1997	6.22	6.12	4.39	82.13	1.14	25.62	14.07	17.70	3.47	39.15
1998	8.01	6.89	5.84	76.91	2.35	23.90	11.57	17.48	2.59	44.47
1999	6.44	4.53	6.81	80.86	1.36	22.93	11.34	15.66	2.90	47.17
2000	3.19	2.33	4.43	88.96	1.09	20.55	10.11	13.17	3.88	52.28
2001	2.97	2.87	4.45	88.48	1.23	20.37	8.75	15.70	6.21	48.96
2002	3.40	2.36	3.91	88.67	1.65	20.20	9.19	16.50	6.41	47.71
2003	3.03	3.77	2.31	88.61	2.28	19.71	10.56	16.06	6.23	47.45
2004	2.07	1.61	1.23	93.31	1.78	17.80	10.23	18.36	6.40	47.21
2005	1.33	1.16	2.22	93.92	1.37	18.10	9.59	19.25	7.82	45.24
2006	1.19	0.78	1.65	95.46	0.92	17.58	8.64	21.77	8.41	43.60
2007	0.93	0.67	1.50	95.81	1.07	17.92	9.20	21.19	9.13	42.56
2008	0.65	0.33	1.46	96.85	0.72	17.11	7.69	24.32	8.86	42.02
2009	1.23	0.33	2.07	95.38	0.99	18.72	7.56	21.03	8.76	43.94
2010	1.17	0.51	1.75	95.41	1.16	16.74	7.21	25.68	8.08	42.30

Source: UNCTAD secretariat calculations, based on UNCTADstat, GlobStat - Merchandise Trade Matrix, Exports.

Table A.II.20: Composition of merchandise exports of developing countries and LDCs, 1995–2010 (Per cent)

Year	Developing countries					LDCs				
	All food items	Agricultural raw materials	Fuels	Manufactured goods	Ores, metals, precious stones	All food items	Agricultural raw materials	Fuels	Manufactured goods	Ores, metals, precious stones
1995	10.13	2.77	15.17	66.69	5.23	20.88	13.76	24.19	22.19	18.97
1996	9.95	2.42	17.21	65.57	4.86	20.07	10.72	30.28	24.31	14.63
1997	9.74	2.16	16.19	67.07	4.83	19.35	11.50	28.87	26.88	13.40
1998	9.93	1.93	12.59	70.58	4.97	19.96	10.41	21.03	34.02	14.59
1999	8.58	1.78	15.52	69.61	4.51	17.51	9.11	28.51	32.12	12.75
2000	6.82	1.62	19.88	67.43	4.25	13.27	6.85	39.58	30.80	9.50
2001	7.53	1.56	18.63	67.98	4.30	13.84	6.55	37.09	31.05	11.48
2002	7.52	1.56	17.24	69.31	4.37	13.52	6.48	39.11	29.40	11.49
2003	7.24	1.57	17.93	68.67	4.59	12.63	7.68	41.19	28.28	10.22
2004	6.57	1.46	19.31	67.58	5.09	10.49	6.23	46.74	26.12	10.41
2005	6.04	1.32	22.87	64.65	5.12	9.03	5.03	54.41	21.50	10.03
2006	5.68	1.31	23.43	63.61	5.96	8.82	4.43	54.98	20.77	11.01
2007	5.99	1.29	22.96	63.60	6.16	8.41	4.43	57.65	19.34	10.17
2008	6.34	1.22	26.80	59.72	5.92	6.83	3.09	63.82	16.22	10.04
2009	7.33	1.20	21.14	63.94	6.39	9.70	3.83	53.44	21.78	11.25
2010	6.86	1.42	21.22	63.56	6.95	8.88	3.83	52.15	21.54	13.60

Source: UNCTAD secretariat calculations, based on UNCTADstat, GlobStat - Merchandise Trade Matrix, Exports.